PREPARATION OF AN AUTOCAD TRAINING MANUAL

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ABSTRACT

The primary objective was to produce an AutoCAD training manual for users with an existing knowledge of manual drawing.

The contents of the manual are basically an illustration of how to use the software, consisting of chapters giving explanations and examples of methods of constructing drawings. The first two chapters are concerned with introducing AutoCAD. These are followed by several chapters on how to draw using the program. The final chapter deals with plotting and printing of the finished drawings. This report contains two appendices; one being the manual itself and the other being drawing standards (BS 308). The approach to creating the manual was to recreate the drawing process step by step and assign chapters in the manual in this sequence to allow users follow the drawing process more effectively.

The means of instruction involved the use of both text and images to ensure users were able to visually follow what they were being taught and hence make it easier for them to grasp the concepts taught. This manual is intended to serve as an introduction to the use of the AutoCAD software.

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CHAPTER 1

1.0 INTRODUCTION

AutoCAD is a (Computer Aided Design) CAD application software for 2D and 3D design and drafting, developed by Autodesk Inc. It was first released in late 1982; AutoCAD was one of the first CAD programs to run on personal computers, and notably the IBM PC. Most CAD software at the time ran on graphics terminals connected to mainframe computers or mini-computers. It is widely used today in architectural and engineering drawings.

In earlier releases, AutoCAD used primitive entities — such as lines, polylines, circles, arcs, and text — as the foundation for more complex objects. AutoCAD includes a full set of basic solid modeling and 3D tools. With the release of AutoCAD 2007 came improved 3D modeling functionality, which meant better navigation when working in 3D. Moreover, it became easier to edit 3D models. It was now possible to do quality renderings..

AutoCAD's native file format, DWG, and to a lesser extent, its interchange file format, DXF, have become de facto standards for CAD data interoperability. AutoCAD in recent years has included support for DWF, a format developed and promoted by Autodesk for publishing CAD data. In 2006, Autodesk estimated the number of active DWG files to be in excess of one billion. In the past, Autodesk has estimated the total number of DWG files in existence to be more than three billion.

AutoCAD currently runs exclusively on Microsoft Windows desktop operating systems. Versions for Unix and Mac OS were released in the 1980s and 1990s, but these were later dropped. Table 1:1 below shows the various versions of AutoCAD that have been released and their date of release.

AutoCAD is available for German, French, Italian, Spanish, Japanese, Korean, Chinese Simplified, Chinese Traditional, Russian, Czech, Polish, Brazilian Portuguese, Danish, Dutch, Swedish, Finnish, Norwegian and Vietnamese. The extent of localization varies from full translation of the product to documentation only.

TABLE 1:1 AUTOCAD RELEASES

OFFICIAL NAME	VERSION	RELEASE	DATE OF RELEASE
AutoCAD Version 1.0	1	1	1982, December
AutoCAD Version 1.2	1.2	2	1983, April
AutoCAD Version 1.3	1.3	3	1983, August

AutoCAD Version 1.4	1.4	4	1983, October
AutoCAD Version 2.0	2	5	1984, October
AutoCAD Version 2.1	2.1	6	1985, May
AutoCAD Version 2.5	2.5	7	1986, June
AutoCAD Version 2.6	2.6	8	1987, April
AutoCAD Release 9	N/A	9	1987, September
AutoCAD Release 10	N/A	10	1988, October
AutoCAD Release 11	N/A	11	1990, October
AutoCAD Release 12	N/A	12	1992, June
AutoCAD Release 13	N/A	13	1994, November
AutoCAD Release 14	N/A	14	1997, February
AutoCAD 2000	15	15	1999, March
AutoCAD 2000i	15.1	16	2000, July
AutoCAD 2002	15.6	17	2001, June
AutoCAD 2004	16	18	2003, March
AutoCAD 2005	16.1	19	2004, March
AutoCAD 2006	16.2	20	2005, March
AutoCAD 2007	17	21	2006, March

AutoCAD 2008	17.1	22	2007, March
AutoCAD 2009	17.2	23	2008, March
AutoCAD 2010	18	24	2009, March 24

For the purposes of simplicity, availability and its ability to run on most standard machines available today AutoCAD 2004 Version 16 was selected as the version of AutoCAD on which the project would be based upon.

The minimum System Requirements for any Computer required to install, run and utilize the AutoCAD 2004 program are:

- Intel Pentium 3 or later, with 800 MHz or faster processor, or compatible.
- Microsoft Windows XP (Professional, Home Edition, or Tablet PC Edition).
- Windows 2000, or Windows NT 4.0 (Service Pack 6a or later).
- 256 MB RAM
- 300 MB Free Disk space for installation.
- 1024*768 Visual Graphics Array with true color.
- Microsoft Internet Explorer 6.0.
- Mouse, trackball, or compatible pointing device.
- CD-ROM drive.

CHAPTER 2

2.0 LITERATURE REVIEW

A wide range of material and tools were used in the completion of this project. Due to the computerized nature of the project requirements most of these materials tended to be in terms of computer software and hardware.

2.1 SOFTWARE COMPONENTS

i. **AutoCAD 2004:** This was the primary software used and was the basis on which the manual was created. The developer was AUTODESK and the version of software was version 2004.0.0. The primary reason for its selection was its wide availability to users. It is the most commonly found version of AutoCAD available in Kenya today. It was also felt that despite there having been newer releases of AutoCAD, AutoCAD 2004 has much of the same functionality and operating techniques as the newer versions. Hence AutoCAD 2004 was the ideal choice on which to create our learning manual.

ii. **AutoCAD 2008:** This was used merely as a comparison with the AutoCAD 2004 software to ensure that instructions being depicted in the 2004 version of AutoCAD would be applicable to the 2008 version. In essence its use was to ensure future proofing of the user manual. The developer was AUTODESK and the version we used was version B.51.0 (UNICODE).

iii. **Microsoft Office 2007:** This software was used as the primary means of instruction and exchange of information to the user through its Microsoft Word 2007 component. All data in terms of text, pictures and graphics in the manual were inputted into this software in order to enable it to be viewed appropriately by a user. The developer was the Microsoft Corporation. The Microsoft Excel 2007 component was used in the generation of graphs and tables.

iv. **AutoDesk Learning assistant 2000:** This was software that aided in the learning of AutoCAD 2000 and it was used to provide useful ideas that could be carried over into our AutoCAD 2004 manual to pass learning instructions more effectively. The developer of this software was AUTODESK.

v. **Microsoft Paint:** This was one of the most important softwares we used and was essential to the inputting of graphics and images in the manual. It was felt images and graphics would enable students grasp what was being taught in a faster and more effective way than plain text alone. The developer was the Microsoft Corporation and the version used was Version 6.0 Build (6.001).

vi. **Adobe Creative Suite 3:** A very important software that enabled the conversion of all text and graphics into Adobe PDF format that was an easier format to utilize in the making of our manual. This was done through Adobe Creative Suite 3's Adobe Acrobat 8 Professional component. In addition graphics were retouched and edited using the Adobe Photoshop component of the suite. The developer of both components was Adobe. The version of

Adobe Acrobat 8 Professional was version 8.0 while that of Adobe Photoshop was Version 10.0.

In selecting the hardware components we needed to ensure that all the above softwares would be able to run on our system and had to be installed simultaneously. This meant a Computer with much higher abilities would be required than just the minimum ability required to install and run AutoCAD 2004. To overcome the extremely heavy performance requirements required to install and run AutoCAD 2008 and Adobe Creative Suite 3 the following ***hardware*** components were used.

2.2 HARDWARE COMPONENTS

2.2.1 COMPUTER SYSTEM ONE (DESIGN MACHINE):

i. Intel Classic Series DG33FB Motherboard.
ii. Core™2 Duo Processor E4500 @ 2.2 GHz, 2MB L2 Cache, 800 MHz FSB.
iii. Vitesta DDR2 800 2GB RAM Chip.
iv. FSP Blue Storm 2 500 Watt Power Supply Unit.
v. 20X Internal Super Multi DVD rewriter (CD, DVD drive).
vi. SBS A30, 2 Watt RMS, Creative Sound Output System.
vii. Micro Genger 4GB Flash Disk.
viii. Digitek Casing.
ix. HighMark PS/2 Pointing device.

The above system was running on **Windows Vista Ultimate (Service Pack 1)** Operating System.

2.2.2 COMPUTER SYSTEM TWO (TEST MACHINE):

This system was designated the brand name Compaq Presario CQ60-220US Notebook Pc and consisted of the following:

i. Mobile Intel(R) 4 Series Express Chipset family
ii. Intel(R) Pentium(R) Dual CPU T3400 @2.16 GHZ, 2.17 GHz.
iii. Mobile Intel(R) GMA 4500M 2GB RAM.
iv. TSST Corp CDDVDW TS-L633M ATA Device (CD, DVD drive).
v. Microsoft PS/2 Pointing Device.

The above system was running on Windows **Vista Home Premium (Service Pack 1)** Operating System.

2.3 STANDARDS USED

The standards chosen for use in this manual were The British Standard (BS 308). The excerpts relevant to the manual are as shown below.

1. Layout of drawings.

- Drawing Sheets
- Title Block
- Types of Drawing
- Drawing Formats

2. Scales.
    - Recommended Scales.
    - Choice of Scales

3. Lines and Linework.
    - Line thickness
    - Types of lines and their application

4. Lettering and Numerals.
    - Style
    - Character Height
    - Direction of Lettering
    - Location of notes
    - Underlining

5. Systems of Projection.
    - Projection Symbols

CHAPTER 3

3.0 OBJECTIVES

The primary objective of our project was to create an AutoCAD training manual that would assist users who have prior knowledge of manual drawing to be able to make drawings using the AutoCAD software. As such this manual would:

- Introduce AutoCAD as a tool that could be used in the technical drawing of engineering components to students who are already proficient in the technical drawing of mechanical components on paper.
- Allow self learning of the software without necessarily having a tutor or lecturer giving instruction to the learner. The manual would therefore be adequate for a student to learn the basics of AutoCAD without the aid of an external tutor.
- Allow a student to be able to know the full range of AutoCAD operations required to produce a competent engineering drawing from the starting and setting up of the drawing to its final plotting. This would mean that the full life cycle for the drawing of any mechanical engineering component from start to finish would be covered in the manual.
- Be a complete but yet simple document that would carry out the above tasks adequately. This would be a manual that is small enough to print out for users as well as being designed in an easy to read and understand manner.

CHAPTER 4

4.0 AUTOCAD VERSION AND STANDARDS SELECTION

4.1 SELECTION OF AUTOCAD VERSION

The first task in the production of the manual was to ensure what was being written was of direct use the engineering student and would enable him/her complement what had already been taught in Engineering Drawing. This would mean the engineering principles applied when drawing on paper would now have to be utilized on the computer using AutoCAD.

The manual would have to convey that that AutoCAD was just a tool used for making drawings in a format suited for computers just as a pencil and ruler were tools used to create drawings on paper. Therefore all principles and rules applying to drawing on paper would apply to the computer drawings generated on the AutoCAD software.

The first decision to be made was to select an appropriate version of AutoCAD to base our manual on. This would mean all instruction and imagery would be obtained from one chosen version of AutoCAD for uniformity. The choice had to be made while looking at balancing the following factors:

- **Availability:** The chosen version had to be readily available in the market whether for sale or for hire.
- **In widespread use:** The version of AutoCAD would have to be in use in majority of engineering organizations or learning centers so as to ensure that students using the manual are learning what is relevant.
- **Simplicity:** There was a need for the selected version of AutoCAD to perform all the necessary functions required pertaining to engineering drawing while still being relatively direct and simple to use.
- **Minimum System Requirements:** Each version of AutoCAD has a different set of minimum system requirements to run any computer. The newer the version of AutoCAD the higher these requirements and we had to ensure our selected version would run on most computers available today at moderate prices.

AutoCAD 2004 Version 16 was selected as the version of AutoCAD on which the project would be based upon as it scored highly in satisfying all the above factors as compared to other choices such as AutoCAD 2008 that required fairly high minimum computer system requirements and were not readily available on the one hand and other choices such as AutoCAD 2000 that are not in widespread use anymore.

4.2 SELECTION OF APPROPRIATE STANDARDS

The next decision at hand at hand was to choose the relevant standards by which engineering drawings would be created and whose specifications would be followed. Since the University of Nairobi Mechanical Engineering Department follows British Standards (BS 308) as the standard of instruction in its Engineering Drawing (FME 161 and FME 162) subject units it was decided that this standard would be appropriate to be used in this manual as it would be primarily used by students of the same Mechanical Engineering Department. These standards specify the type of lines that can be used for any kind of intended application and the required line thickness for that application. They also show Drawing sheet sizes available and their Designations as well as giving guide lines on text height, spacing and character type that should be used in drawings. The manual to be created would follow all the set specifications of British standards (BS 308).

CHAPTER 5

5.0 THE ENGINEERING DESIGN PROCESS IN AUTOCAD

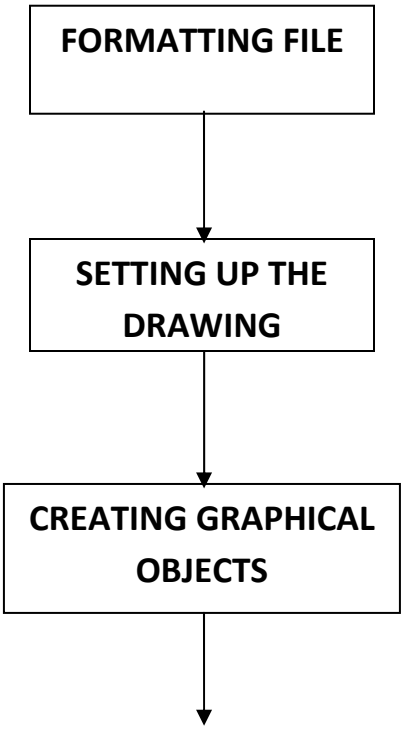
One of the important concepts in the manual was the selection and intended sequential arrangement of chapters. The intended chapters were to enable the competent drawing of a component from its starting and setting up to its final form and output. Therefore it had to be ensured that the entire Life Cycle for a mechanical engineering drawing was covered appropriately within the manual, and that the chapters followed a clear, concise and step by step arrangement from the start to the finish. The manual would consist of the two following types of data:

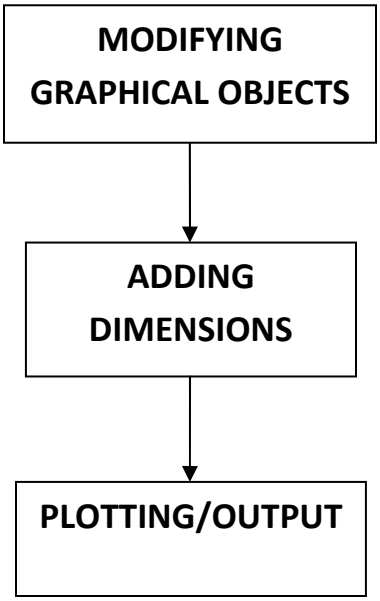
- **The Design Process Chapters:** These chapters described in detail each stage of the drawing process. Every stage would have a chapter associated with it and the chapter sequence would mirror step by step that of the actual engineering drawing process.
- **Subsidiary Chapters:** These chapters were not part of the actual engineering drawing process but were used to assist the student understand concepts relevant to the use of AutoCAD 2004.

5.1 DESIGN PROCESS CHAPTERS

These follow the steps required to create a complete AutoCAD 2004 engineering drawing from start to finish. Each step has an associated chapter and the stages of the drawing process are as indicated below in Fig 5:1

Fig 5:1 THE DESIGN PROCESS





i. **Formatting File:** This is the first stage of the drawing process when using AutoCAD. After selection of our standards the drawing tools we would use needed to be assigned the correct format that adhered to our selected standards before any drawing takes place. This chapter would thus explain how to adjust ***Layer, Color, Linetype, Lineweight, Text Style, Dimension Style, Plot-Style, Point Style, Multi-line style, Units, Thickness,*** and ***Drawing Limits*** to do this.

ii. **Setting Up the Drawing:** The next stage would be to start and set up the drawing area in readiness for actual drawing. Thus the three different methods that could be used to perform this function are listed and explained indicating where and when each is suitable.

iii. **Creating Graphical Objects:** The drawing process is next to be carried out and is done using the draw tools. Hence the next chapter would indicate the most important Draw Tools and their functions and uses. A set of practice exercises would also be added at the end for the student to try replicate using the draw tools he/she has learnt by reading through the chapter.

iv. **Modifying Graphical Objects:** During and after the drawing process, modifications are normally done to the drawing. Hence a detailed explanation on the most important Modify Tools and their functions.

v. **Adding Dimensions:** After the drawing of any engineering component is complete, dimensions are needed. This chapter therefore explains each of the various kinds of dimension lines and types available as well as how and when to use them.

vi. **Plotting/Output:** The final stage of the AutoCAD drawing process is the final output or plotting of the drawing on paper. This chapter intended to show how to set up a printer, assign the correct printing layout to any drawing and produce the final print out to meet required specifications.

5.2 SUBSIDIARY CHAPTERS

These chapters were to be used to assist the student better grasp the use of AutoCAD 2004 by giving extra information that was not necessarily part of the drawing process. These included:

i. **General File Handling:** This chapter would explain common file handling techniques that included file opening, closing, saving and printing of drawings. It is used as a reminder in the use of these necessary techniques before we go into the main design chapters.

ii. **The Start-Up Screen:** This would provide an elementary knowledge of the first screen to be seen upon installation of the AutoCAD 2004. A snap shot of this screen with all components labeled was added to allow a student become visually familiar with the AutoCAD menus, drawing area and controls.

iii. **Appendix:** This section of the manual was intended to provide useful information as relates to the British Standards (BS 308) that is applicable in the use of AutoCAD 2004 to draw mechanical engineering components. It would consist of three tables consisting of types of lines and their widths and applications, text character heights and paper output plotting specifications.

CHAPTER 6

6.0 FORMAT AND LAYOUT OF MANUAL

The design and layout of the manual would have to be arranged in a way that was conducive for users to learn AutoCAD 2004 in the easiest and simplest way possible consisting of a minimum number of steps. This was done by use of the following tools and methods:

i. For any given task the most direct route with the fewest and simplest operations was used so as to enable the student grasp the concept being taught faster and more comfortably.
ii. Key words and functions within the manual that had importance were italicized and were made bold to add emphasis to key concepts and help the user remember them.
iii. The manual was designed to be as short as possible so as to ensure it was not too bulky or too tedious to read while making it more interesting and encouraging for the user to read.
iv. A number of graphics and images were added to incorporate a visual learning element to the manual and enable users learn faster as well as make it more interesting to read.
v. An adobe PDF version of the manual was created to be used by users with computers for those who felt more comfortable learning AutoCAD 2004 through that means.
vi. A series of practice exercises were included in the manual so as to enable users practice what they have learnt and perfect it.

6.1 CREATION OF GRAPHICS AND IMAGES FOR MANUAL

The creation of appropriate graphics and images to supplement the text used in the manual was a lengthy process and involved a combination of softwares. For each graphic and image the general procedure was as follows.

i. Using AutoCAD 2004 the appropriate operation is carried out until the screen displays the output you want to capture the graphic of.
ii. A screen capture command is used to capture the contents of the whole screen currently on display. The Print Screen button that is present on most keyboards can perform this function. It is located in between the ‘Scroll Lock’ and ‘F12’ keys. It stores a ‘snapshot’ of what is on the screen when the button is pressed.
iii. Image editing software is now used to edit the selected captured screen. We used Microsoft Paint for this purpose though Adobe Photoshop could also be used. After running the Microsoft Paint application we used the ***Edit*** menu and selected the ***Paste*** option to paste the whole screen captured into the application. Editing is now done and this includes cropping to extract only the necessary part wanted from the whole captured screen, adding text and captions as well as adding colors, leader lines and

finally saving the final version of the graphic. Adobe Photoshop and Microsoft Paint softwares were ideal for this purpose.

iv. In the text editor (Microsoft Word), as we typed the document the relevant graphics and images were put into the required positions. This was done by opening the saved Microsoft Paint edited screen shot we had captured, edited and saved. We then used the ***Select*** tool to select the area wanted, right clicked and selected ***Copy***. The next step was to go to the point we wanted the graphic and right click again and select ***Paste*** to insert the graphic into the required place.

6.2 CONVERSION OF MANUAL INTO ADOBE PDF FORMAT

The text document would have to be converted into Adobe PDF format for easier use and to prevent students from tampering with the layout of the manual as well as to prevent mixing up of data when the document is opened up on different computers in the Microsoft Word format. The general procedure followed was as follows:

i. The Adobe Creative Suite 3 software was installed into our computer.
ii. Next Adobe Acrobat was added as a default printer using the 'Add Printer Wizard'.
iii. The text document to be converted was opened and the ***Print*** menu selected.
iv. In the select printer option select the ***'Adobe PDF'*** printer and click ***Ok***.
v. The save location and filename is chosen after which the ***Save*** button is selected.

CHAPTER 7

7.0 STRUCTURE OF THE MANUAL

Once the core chapters had been ascertained there now the problem of what were the most important concepts that were part of each chapter that had to be explained to students using the manual. Each chapter was therefore systematically broken down into smaller subtopics that could be explained individually with the detail each required. An effort was made to avoid any unnecessary content that would make the manual bulky. After intensive deliberation the individual chapters were broken down into the following sub-chapters or had the following information.

CHAPTER 1: GENERAL FILE HANDLING

- **Opening files**: General tutorial on how to open files.
- **Saving files**: General tutorial on how to save files.
- **Closing files**: General tutorial on how to close files.
- **Printing or Plotting**: General tutorial on how to print or files.

CHAPTER 2: THE START UP SCREEN

- A labeled image of the start up screen is given with explanation.
- **The Toolbars:** Images and explanation of various toolbars used in AutoCAD 2004.
- **Palettes:** Images and explanation of various toolbars used in AutoCAD 2004.

CHAPTER 3: FORMATTING

- **Formatting layers:** Tutorial on how to format Layers and their properties.
- **Formatting Dimension styles:** Tutorial on how to format Dimension styles.
- **Formatting Drawing units:** Tutorial on how to format Drawing units.

CHAPTER 4: STARTING AND SETTING UP DRAWINGS

- This would explain the various methods of starting drawings and when to use them.

CHAPTER 5: THE DRAW COMMANDS

- Images of the important Draw commands and how they are used.
- **Practice Exercises:** A series of drawings for the user to practice what he has learnt in the manual.

CHAPTER 6: THE MODIFY COMMANDS

- Images of the important Draw commands and how they are used.

CHAPTER 7: DIMENSIONING

- Images of the various dimensioning lines available and their use.

CHAPTER 8: PLOTTING AND VIEWPORTS

- **Layouts:** How to use layouts and their editing.
- **Viewports:** How to set viewports and their editing.
- **Plotters and Plotting:** How to plot drawings.

APPENDIX

- Various British Standard (BS 308) that are relevant to AutoCAD drawing are listed here.

CHAPTER 8

8.0 RESULTS – AUTOCAD 2004 TRAINING MANUAL

The training manual is included as an Appendix 2 in the Appendix Section of the Report.

CHAPTER 9

9.0 TESTING AND REVIEW

After the manual was created it was important to test it in AutoCAD learning institutions and by professional users of AutoCAD who use it in industry.

Two field tests were conducted. The first one was done at the Numerical Machining (NMC) Complex Ltd who are the premier dealers in AutoCAD software in Kenya and are Computer Aided Designers and manufacturers of industrial and automotive parts. The review was done By Engineer Robert Kasamu who is the Production Engineer at NMC.

The manual was found to be very good for anyone just beginning to use the AutoCAD software and it was recommended as a starting point that could be used with or without physical tutoring.

It was felt that it covered most aspects of component drawing adequately and the flow of the document followed a good learning sequence. The use of imaging was hailed as very helpful to the learner. Its small size was seen as very convenient as well as its availability in Adobe PDF, Microsoft Word and hard copy form. However Engineer Kasamu felt the following should also perhaps have been included in the manual:

- A section on the use of the AutoCAD 2004 ‘Help’ and how it can be used to assist in the drawing process.
- A section on the use of the User Coordinate System (UCS), relative and absolute coordinates as part of the introduction to drawing.
- More practice exercises on each of the tools and their uses.

The second field test was done at Bell Institute of Technology, an Institute for AutoCAD training by Mr. Hannington Yobera a Technical AutoCAD Instructor. His view was that the manual was a perfect introduction to 2D Drawing for students new to AutoCAD. He especially commended the clarity of text and the systematic use of steps that follow each other in an organized fashion. He also suggested the following:

- Slightly more information should be given on dimension styles and layers.
- More information should have been given on the use of the ‘Text Tool’ and more explanation was needed on how to load ‘Linetypes’.
- An introduction to 3D drawing also be included as a chapter.

CHAPTER 10

10.0 CONCLUSION AND RECOMMENDATIONS

After reviewing the final document and adequate testing on both engineering students as well as industrial AutoCAD users the following conclusions were arrived at.

- The manual was a suitable instruction tool for AutoCAD 2004 software for and hence satisfied one of its principal objectives.
- The manual was adequate for use for self learning of AutoCAD 2004 which was another objective that we needed to satisfy. The step by step approach to each stage in making a drawing was suitable for the learning process.
- The use of graphics was a very useful tool in the learning process of AutoCAD 2004 and together with text made it for an easier learning process. The use of actual screenshots was innovative and made understanding concepts simpler and faster to grasp.
- Due to the vast nature of AutoCAD not all concepts of AutoCAD 2004 was able to be included in the manual in the interest of cutting down on size and simplicity. Certain concepts such as the 'Help' function and the 'User Coordinate System' and '3D drawing' were not able to be included.
- The availability of the manual in Adobe PDF form was seen as accommodating to students who could not print out the whole document but had access to computers and could still therefore receive instruction in AutoCAD 2004.
- The manual was seen as suitable as a syllabus text and could adequately form a course text for the Introduction to AutoCAD course that the University of Nairobi wanted to introduce for Mechanical Engineering students.

The manual therefore managed to satisfy all required objectives adequately meaning it could now be produced or distributed as an official Mechanical Engineering Department document. However we as authors had the following recommendations as regards to the manual.

- The manual be distributed to Engineering Students as 'An Introduction to AutoCAD 2004'as part of their study of AutoCAD 2004.
- The manual be used as a main course text for the intended AutoCAD classes for engineering students.
- The manual be supplemented with more practice exercises for each tool to enable more practice for users.
- A second part to the manual be written as a final year project for the following year that will now cover the Advanced concepts of AutoCAD 2004 as a continuation to this manual. These further topics include 3Ddrawing and the User Coordinate System (UCS).

REFERENCES

- YARWOOD, ALF. (2007). Introduction to AutoCAD 2008, 2D and 3D design. Publisher: Newnes Publications, Branch of Elsevier's Science and Technology Department, Oxford, UK.

- MAC BRIDE, (2006). Teach yourself AutoCAD 2007, McGraw Hill Publications.

- EN/WIKIPEDIA.ORG Online Encyclopedia.

- AutoCAD 2004, Published by AUTODESK.

- AutoCAD Learning Assistance (2000), Published by AUTODESK.

APPENDIX 1 (British Standards 308)

1 Layout of drawings

Drawing sheets

The 'A' series of drawing sheets shown in figure 1 is normally used. The drawing area and title block should be within a frame border. In general, material within the frame border forms part of any contract requirements.

A4 = 210 mm × 297 mm
A3 = 297 mm × 420 mm
A2 = 420 mm × 594 mm
A1 = 594 mm × 841 mm
A0 = 841 mm × 1189 mm
The sides of all sheets are in the ratio 1 : √2

A0 is nominally one square metre in area and forms the basis of the series

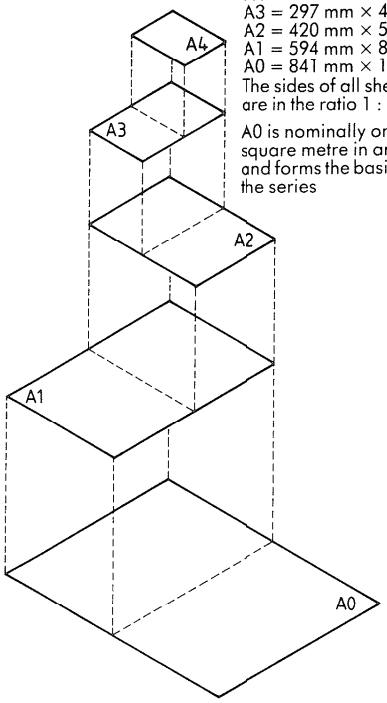


Figure 1. Relationship of the 'A' sizes

Title Block

The title block should be at the bottom of the sheet and extending to the lower right-hand corner of the frame.

Drawings should include the following basic information in title blocks:

(a) name;

(b) date;

(c) projection symbol (see section 5);

(d) original scale (see section 2);

(e) title;

(f) drawing number.

Types of drawings

There are different types of drawings, two of which are shown in figure 2.

For further information on item referencing, shown in figure 2(d), see section 8.

Drawing formats

Drawing sheets have two formats.

(a) *Portrait:* intended to be viewed with the longest side of the sheet vertical, see figure 2(a).

(b) *Landscape:* intended to be viewed with the longest side of the sheet horizontal, see figure 2(b), (c) and (d).

2 Scales

General

Every drawing should be drawn in proportion, i.e. to a uniform scale. The scale used should be stated on the drawing as a ratio, e.g. ORIGINAL SCALE 1:2. The words full size, half size, etc., should *not* be used.

Recommended scales

These are as follows:

Full size

1:1

On drawings smaller than full size (reduction scales):

1:2	1:5	1:10
1:20	1:50	1:100
1:200	1:500	1:1000

On drawings larger than full size (enlargement scales):

2:1	5:1	10:1
20:1	50:1	

Choice of scales

The scale to be chosen for a drawing depends on the size of the drawing sheet and the size of the object to be depicted. The scale should be large enough to permit easy and clear interpretation of the information. Details that are too small for clear dimensioning in the main representation should be shown in a separate view to a larger scale. See figure 13.

3 Lines and linework

Presentation

All lines should be uniformly black, dense and bold. Lines should be all in pencil or all in black ink.

Line thickness

Two thicknesses of line are recommended: thick and thin. Thick lines should be twice as thick (wide) as thin lines.

Types of line and their applications

See table 1 and figure 3.

Dashed lines (type E). The dashes should be of consistent length and spacing, approximately to the proportion shown in table 1. Dashed lines should start and end with dashes in contact with the hidden or visible lines from which they originate, except when the hidden line continues a visible line. Dashed lines should also meet with dashes at tangent points and corners.

Chain lines (type F, G and H). All chain lines should start and finish with a long dash, but note the length of the thick dash at the ends of the cutting plane line (type G) and at the changes of direction.

Where centre lines define centre points they should cross one another at long dash portions of the line.

Centre lines should extend only a short distance beyond the feature or view to which they apply. If required for dimensioning they should continue as projection lines. Common centre lines should not extend across the space between adjacent views.

Centre lines should not stop at another line of the drawing.

Where angles are formed in chain lines, long dashes should meet or cross at corners.

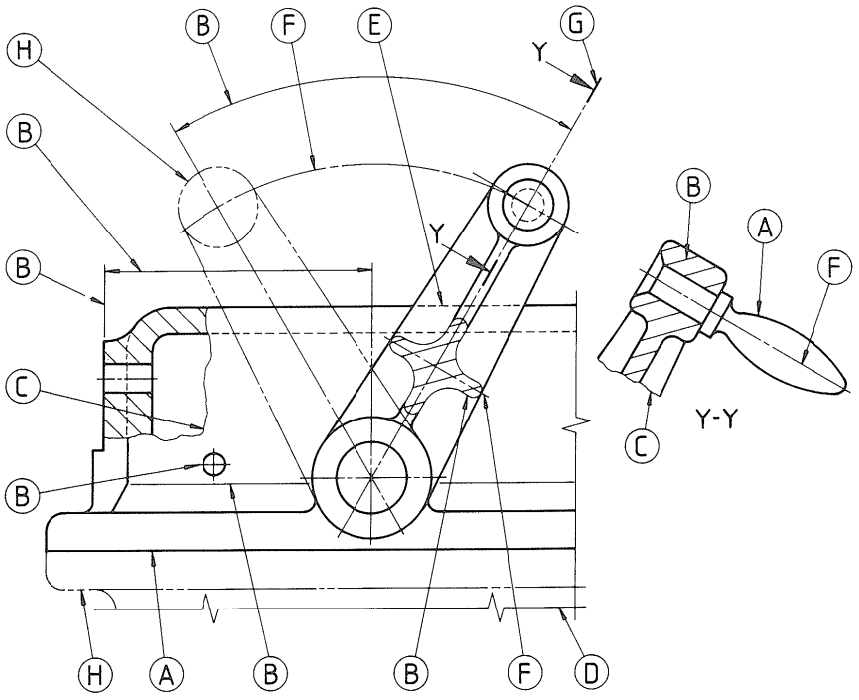


Figure 3. Applications of the various types of line

Table 1. Types of line

Line	Description	Application
A	Continuous thick	Visible outlines and edges
B	Continuous thin	Dimension, projection and leader lines, hatching, outlines of revolved sections, short centre lines, imaginary intersections
C	Continuous thin irregular	Limits of partial or interrupted views and sections, if the limit is not an axis
D	Continuous thin straight with zigzags	
E	Dashed thin	Hidden outlines and edges
F	Chain thin	Centre lines, lines of symmetry, trajectories and loci, pitch lines and pitch circles
G	Chain thin, thick at ends and changes of direction	Cutting planes
H	Chain thin double dashed	Outlines and edges of adjacent parts, outlines and edges of alternative and extreme positions of movable parts, initial outlines prior to forming, bend lines on developed blanks or patterns

Coinciding lines

When two or more lines of different type coincide, the following order of priority should be observed:

(a) visible outlines and edges (type A);

(b) hidden outlines and edges (type E);

(c) cutting planes (type G);

(d) centre lines, etc. (types F and B);

(e) outlines and edges of adjacent parts, etc. (type H);

(f) projection lines (type B).

Figure 4 illustrates the more common priorities of coinciding lines.

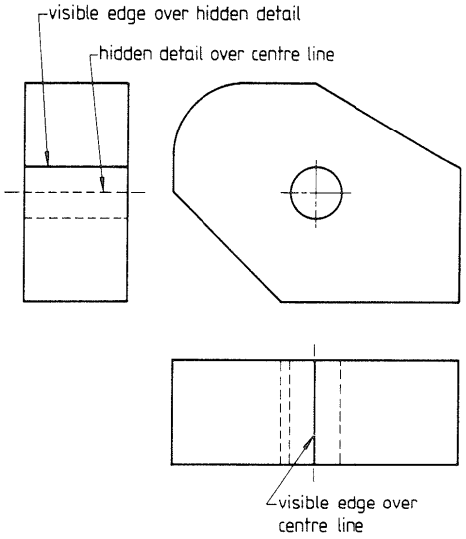
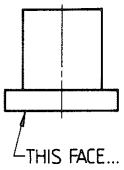
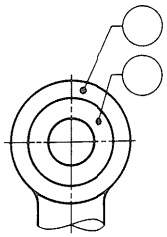


Figure 4. Priority of coinciding lines



(a) Leader line terminating in arrowhead



(b) Leader lines terminating in dots

Figure 5. Typical leader lines

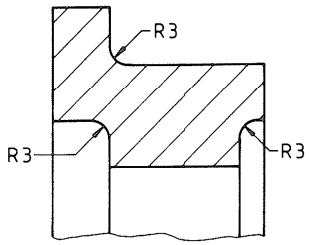


Figure 6. Dimensions repeated to avoid long leader lines

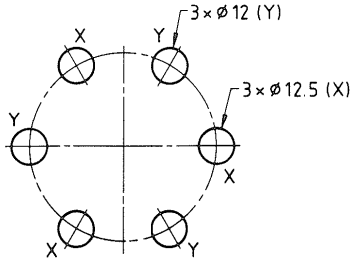


Figure 7. Letter symbols used to avoid long and intersecting leader lines

Leader lines

Leader lines are used to show where dimensions or notes apply. They are type B lines (see table 1) ending in arrowheads or dots. Arrowheads always touch and stop on a line; dots should be within the outline of an object (see figure 5).

An arrowed leader line applied to an arc should be in line with the arc centre.

When applied to a straight line an arrowed leader line should be nearly normal to the line.

Long or intersecting leader lines should not be used even if this means repeating dimensions or notes (see figure 6) or using letter symbols (see figure 7).

Leader lines should not pass through the intersection of other lines.

Arrowheads

Arrowheads should be triangular, with the length approximately three times the width, formed with straight lines and symmetrically placed about the dimension line, leader line or stem. Arrowheads should be filled in.

Sizes. Arrowheads on dimension and leader lines should be 3 mm to 5 mm long. Arrows showing direction of viewing should have arrowheads 7 mm to 10 mm long. The stem of such arrows should be approximately the same length as the arrowhead, but not less than this.

4 Lettering and numerals

General

Clarity, style, spacing and size are important. Numerals especially should be drawn clearly as they often have to be read on their own. All strokes should be black and of uniform density.

Style

In general, capital letters should be used. Some suggested examples of letters and numerals are shown in figure 8.

ABCDEFGHIJKLMNOPQRST
UVWXYZ
1234567890

ABCDEFGHIJKLMNOP
QRSTUVWXYZ
1234567890

Figure 8. Examples of letters and numerals

Character height

The dimensions and notes should be not less than 3 mm tall. Titles and drawing numbers are normally larger.

Direction of lettering

Notes and captions should be placed so that they can be read in the same direction as the information in the title block. For dimensions see section 11.

Location of notes

Notes of a general character should be grouped together and not spread over the drawing.

Notes relating to specific details should appear near the relevant feature, but not so near as to crowd the view.

Underlining

Underlining of notes is not recommended. Larger characters should be used to draw attention to a note or caption.

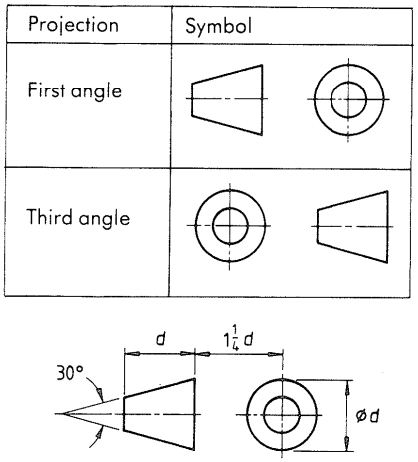
5 Systems of projection

General

Either first or third angle projection may be used. Mixed projections on one drawing are undesirable. If, exceptionally, a view cannot be conveniently shown in its correct projected position, the direction of viewing should be clearly shown. An arrow and view title may be used, similar to those in figure 12.

Projection symbols

The system of projection used on a drawing should be indicated by the appropriate symbol given in figure 9.



Recommended proportions

Figure 9. Symbols indicating method of projection

APPENDIX 2 (RESULTS)

AutoCAD 2004 TRAINING MANUAL

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CHAPTER 1

GENERAL FILE HANDLING

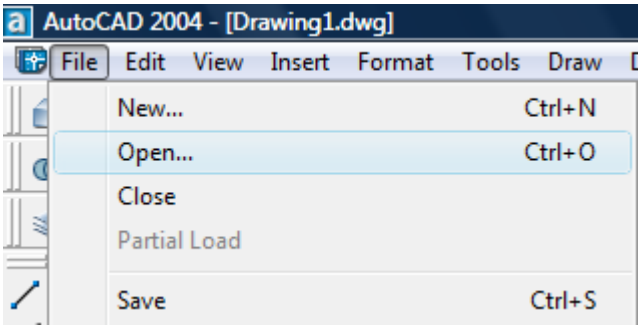
File operations in AutoCAD resemble file operations in any other Windows program. General file handling includes ***file opening***, ***file saving***, ***file closing*** and ***printing*** of drawings.

OPENING FILES

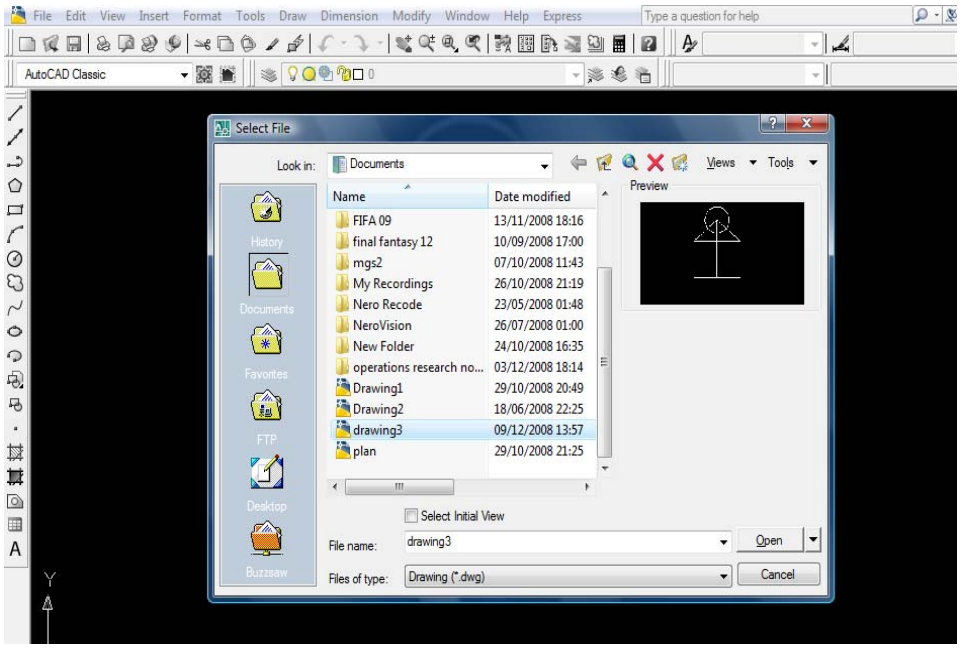
You can have any number of files open at once in AutoCAD.

To open any file proceed as follows.

1. Click the ***File*** menu and select ***Open***.



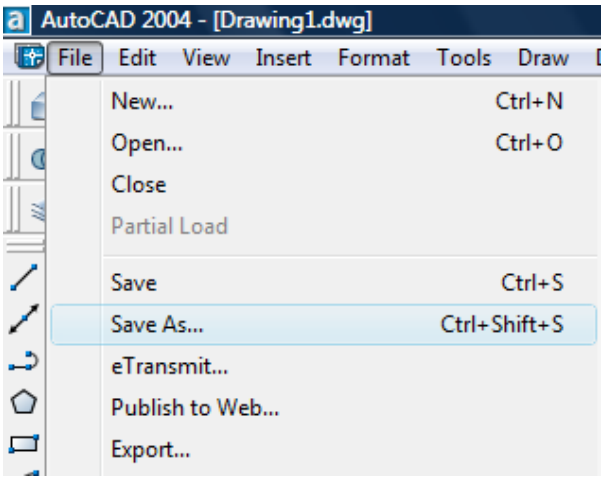
2. At the ***Select file*** dialogue box, browse through to the folder in the ***Look in*** slot. Clicking on a file allows you to look at a preview of the drawing.



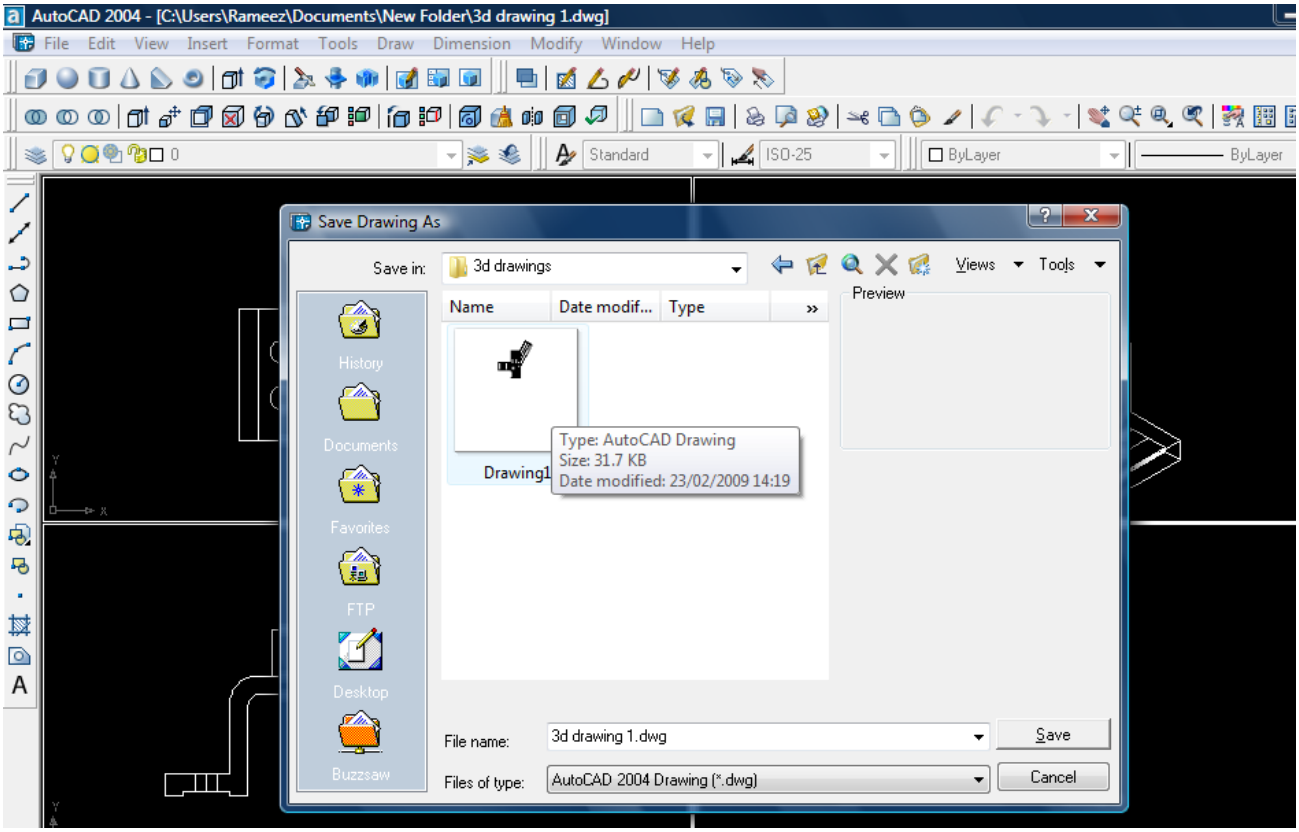
3. Click ***Open*** to view the selected drawing.

SAVING FILES

1. Open the ***File*** menu and select ***Save As*** to open the ***Save Drawing*** as dialogue box.



2. Check that the folder in the ***Save In*** slot is the right one. If it is not click the down arrow on the right of the box to select the right folder.



3. Give the file a meaningful name.
4. Click ***Save.***

NB: To resave a file select ***Save*** from the ***File*** menu or click the ***Save*** button

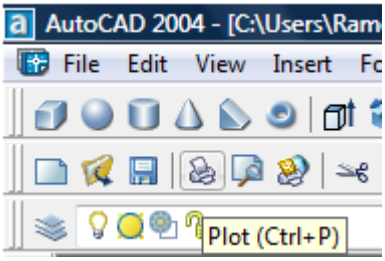
CLOSING FILES

Open the ***File*** menu and select close. If the file has not been saved recently you will be prompted to save it.

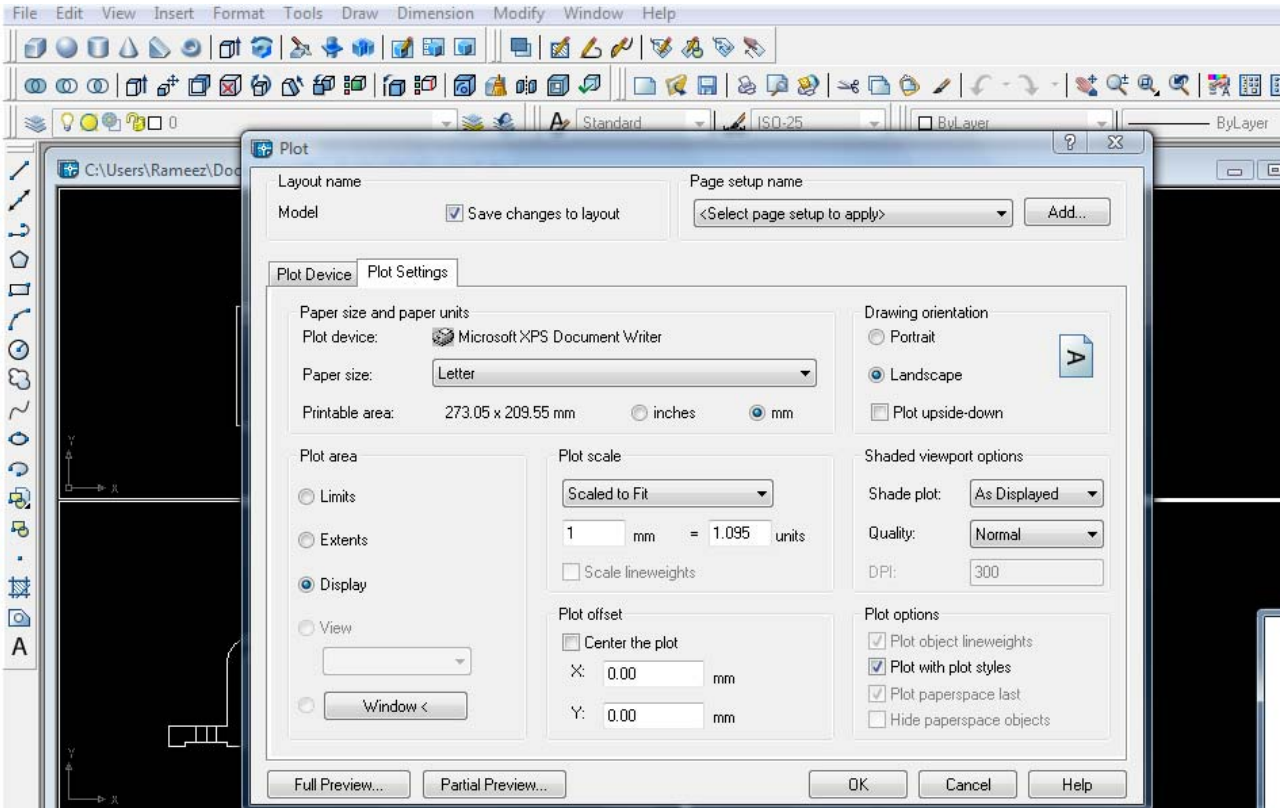
PRINTING OR PLOTTING

Printing or plotting a drawing on screen using AutoCAD 2004 can be carried out from either ***Model Space*** or ***Paper Space***. In versions of AutoCAD before 2004 it was necessary to print or plot from ***PSpace.***

1. With a drawing to be printed or plotted on screen, click the ***Plot*** tool icon in the ***Standard Annotation*** toolbar.



2. The ***Plot*** dialog appears. Set the ***Printer/ Plotter*** to a printer or plotter currently attached to the computer and the ***Paper Size*** to a paper size to which the printer/plotter is set.

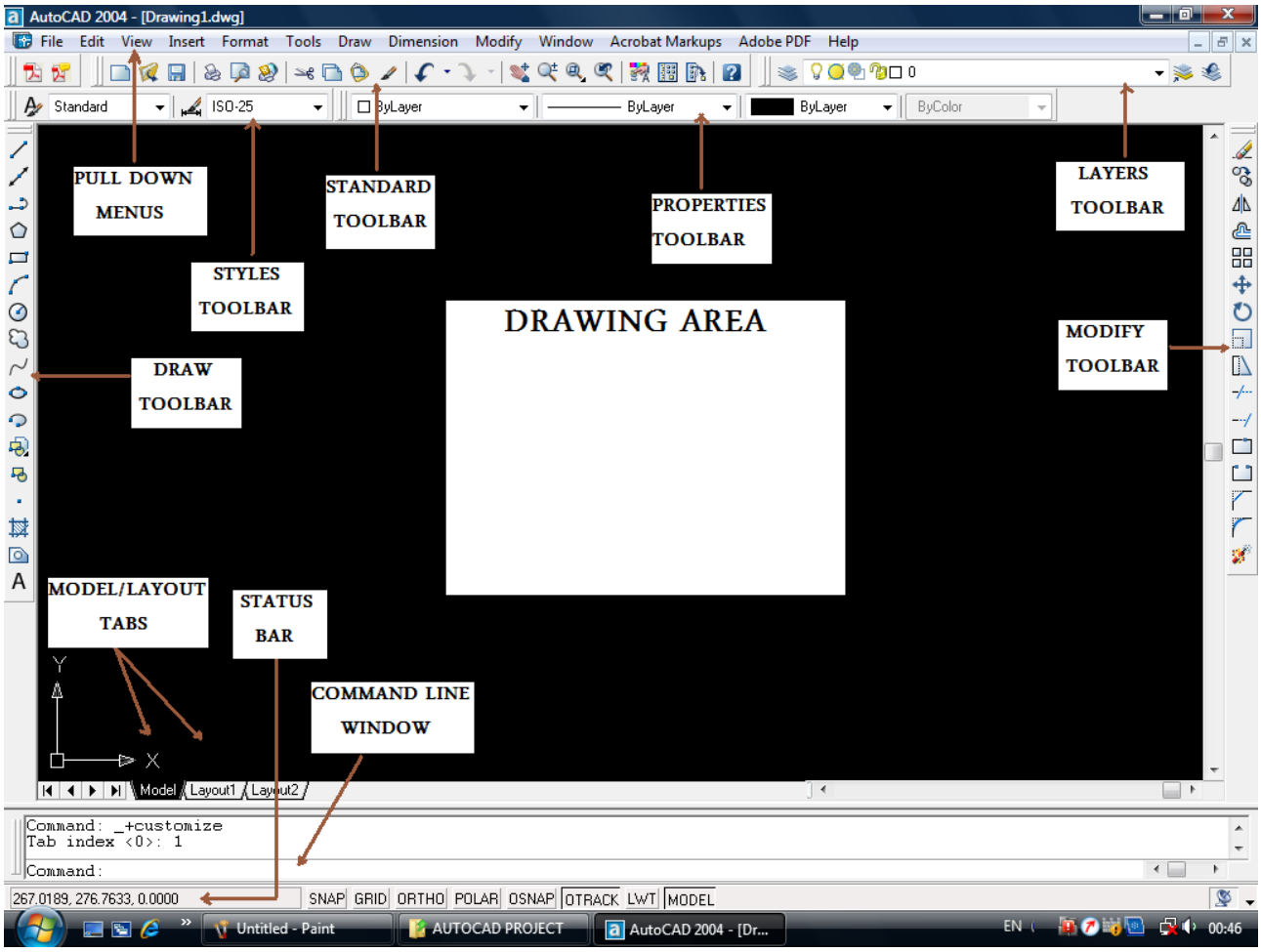


3. Click the ***Preview*** button of the dialog box and if the preview is ok, in the right click menu that appears click ***OK***.

CHAPTER 2

THE START UP SCREEN

When the AutoCAD 2004 window first opens, it should display a blank drawing ready for you to start work on a new project.



The main areas and features of AutoCAD window are indicated on the preceding screenshot. Important features to note include:-

DRAWING AREA: This can display model space or paper layout space. It is the area in which drawings are made and constructed.

COMMAND LINE WINDOW: This is used for entering coordinates. Commands can also be entered here, though it is often simpler to use the menus or toolbars.

PULL DOWN MENUS: These are menus that upon clicking pull down to reveal further sub-menus.

STATUS BAR: This bar indicates the coordinates in the x and y axis with reference to a base point of the mouse pointer within the drawing area..

THE TOOLBARS

STANDARD TOOLBAR: This toolbar contains the same filing, printing and copying tools that you will find in most Windows applications, plus tools to move and zoom around a drawing, and ones to turn the more–used palettes on and off.

DRAW TOOLBAR: This holds the most commonly used drawing tools. The full set can be found in the Draw menu.

MODIFY TOOLBAR: This has tools for moving, rotating, mirroring and otherwise manipulating objects.

PROPERTIES TOOLBAR: This is used for setting the colour, weight and style of lines.

LAYERS TOOLBAR: The main part of this toolbar consists of a drop-down list where you can see and control the key properties of layers. These key properties are explained in depth in Chapter 3 that deals with Formatting.

STYLES TOOLBAR: This toolbar is used to control the text and the dimension lines used in AutoCAD drawings and alter their style to meet requirements.

The toolbar layout is not fixed and can easily be changed to suit your current drawing. Toolbars can be turned on and off, and can be moved to new positions.

To turn toolbars on and off:

1. Right click on any toolbar and the full list will appear. Those toolbars currently displayed will have ticks by their names.
2. Click on a toolbar name to toggle its display on or off.

***SNAP*:** When snap is on, the cursor under the mouse control can only be moved in Jumps from one snap point to another. It is also toggled using F9 key.

***GRID*:** When on, a series of grid points appears in the drawing area It is also toggled using the F7 key.

***POLAR*:** When set on, a small tip appears showing the directions and length of lines, etc in degree and units. Toggled using F10 Key.

***OTRACK*:** When set on lines can be drawn at exact coordinates points and prepares angles.

***ORTHO*:** When on lines etc can only be drawn vertically or horizontally. It is also toggled using the F8 Key.

OSNAP: When on, osnap Icon appears at the cursor pick box. It is also toggled using the F3 Key.

LWT: When set on line weights show on screen. When set off line weights only show in plotted / printed drawings.

NB

When constructing drawings in Auto CAD. It is advisable to toggle between ***Snap,Ortho, Osnap*** and the other functions in order to make constructing easier.

A left-click of the clear ***screen button*** results in a screen clear of one but the menu bar and the command palette.

PALETTES

A palette is a cross between a toolbar and a dialog box and provides alternative routes to commands, options and information.

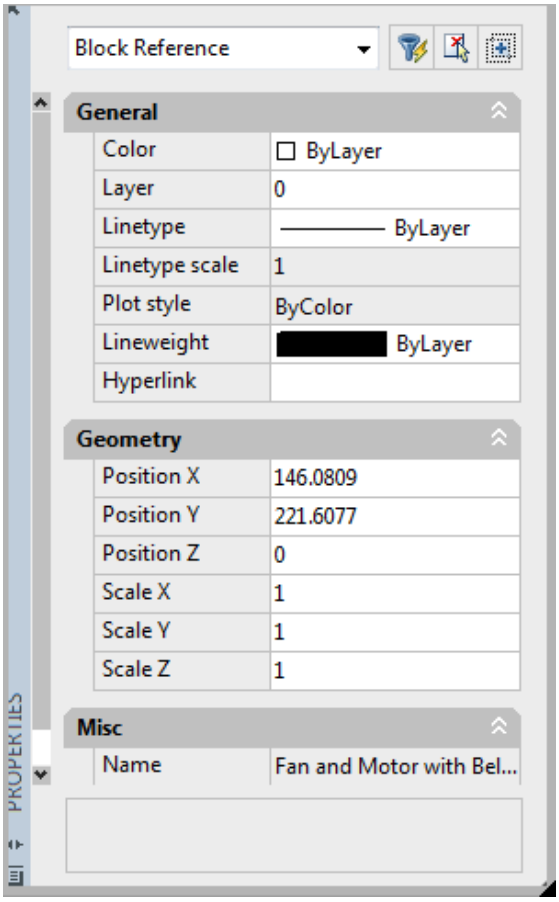
Three palettes which may be frequently used are the ***Properties palette, Design Centre palette*** and ***Tool palette.***

To display a palette:

1. Open the ***Tools*** menu, point to ***Palettes.***
2. Click on the one you want.

PROPERTIES PALETTE

This displays and allows you to change the properties of the currently selected object(s).



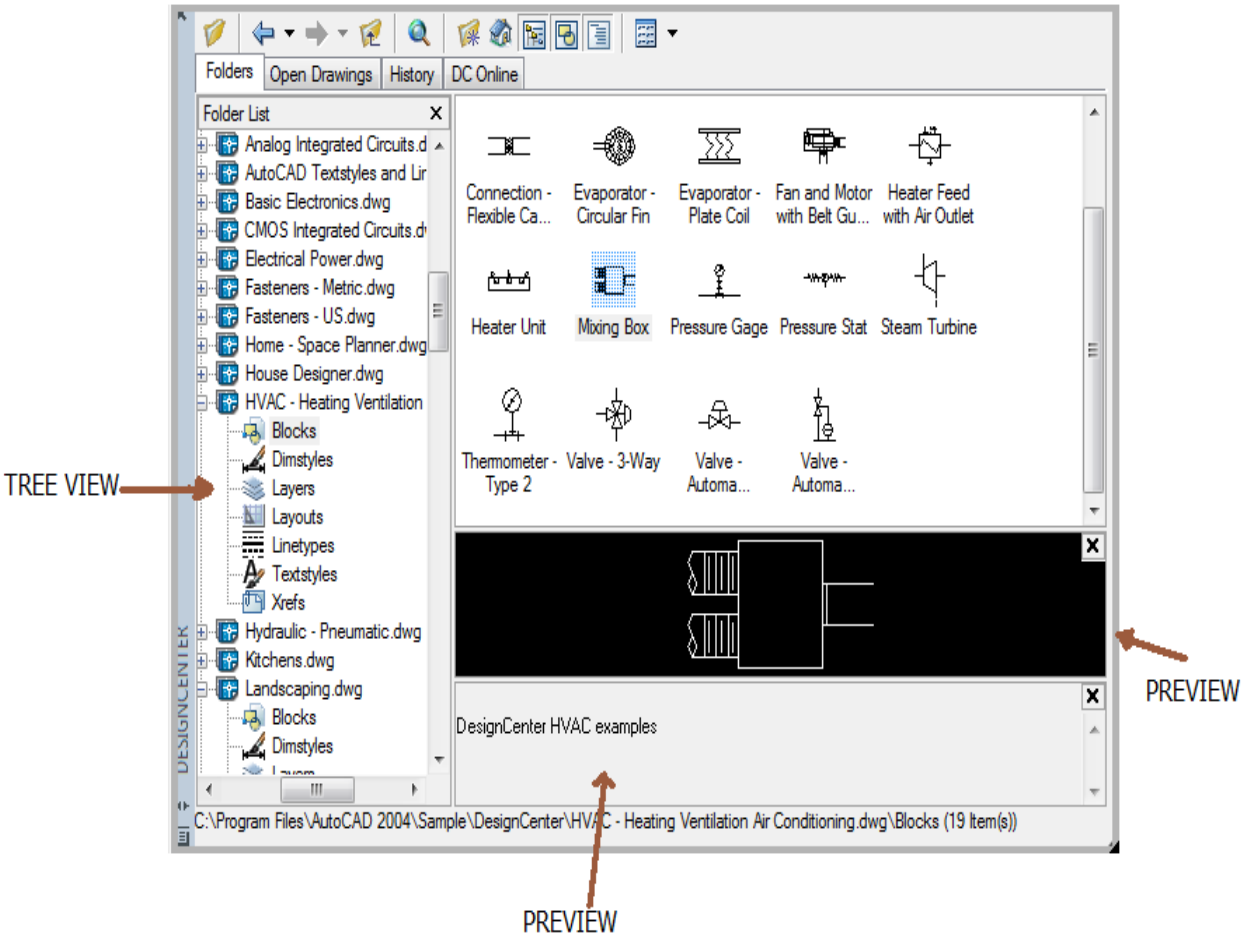
DESIGN CENTRE PALETTE

This gives easy access to the blocks and other features of drawing files on the system including objects in the sample files that are supplied with AutoCAD.

The palette has four panes – three of which are optional:

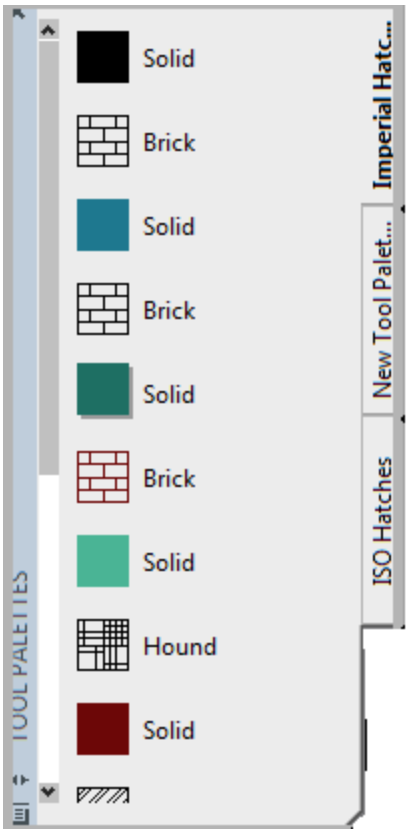
- ***Tree view:*** This shows the folders, which can be opened to show the drawings and their elements.

- ***Preview:*** This gives a close-up of the selected block.
- ***Description:*** This gives the specification of the selected block.



TOOL PALETTE

This holds different sets of tools, giving access to all the essential tools for a variety of jobs. It consists of a set of palettes fitted intone structure, and has extra commands on the shortcut menu to control its contents.



DRAWING STANDARDS

AutoCAD provides several national drawing standards, as well as International Standards Organization (ISO) standards. Standards specify features such as the Drawing Paper sizes. Appendix A, B, C shows drawing standards for linetype, linesize and paper size according to British standard BS 308.

CHAPTER 3

FORMATTING

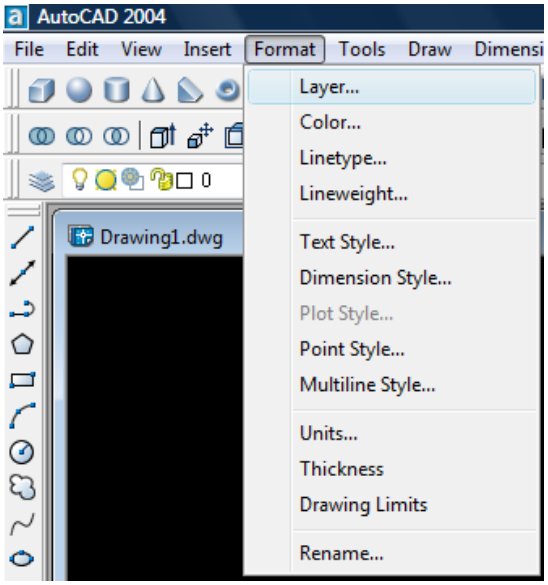
Format pull down menu groups commands for setting features of a drawing that can be specified infrequently during the drawing. These are features such as ***Layer, Color, Linetype, Lineweight, Text Style, Dimension Style, Plot-Style, Point Style, Multi-line style, Units, Thickness,*** and ***Drawing Limits.*** A property such as Layer can be made to house other properties such as ***Color, Linetype, Lineweight*** and ***Plot-Style***, so that the other properties are ***Set by Layer***. Graphical objects created in the layer then inherit all properties set for the layer. Opening the layer then defines properties on that layer for graphical objects created on it.

FORMATTING LAYERS

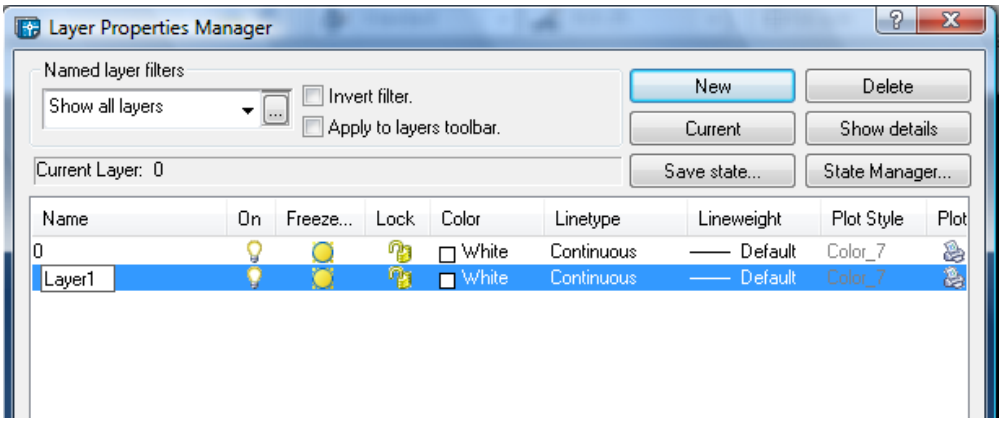
When starting a drawing you can use a template depending on the colour and layout setting you want for your drawing. The ***Acadiso.dwt*** template is a metric unit drawing template while ***Acad.dwt*** is an inch unit template.However, we may want our drawings to conform to another standard. An example of a standard is the ***BS 308: (British Standards)***. This will be the reference standard used throughout this manual. (See Appendix A). The lines to be used in this standard have different properties and line widths. Each of these lines can be constructed by the use of ***layers.*** A ***Layer*** is an equivalent of an overlay sheet in paper based drawing. It helps to assign a colour, line type and line weight to a layer which helps to identify sets of features and gives consistency to their appearance. These are then used according to when they are needed.

To create a new layer:

1. Open the ***Format*** menu and select ***Layer.***

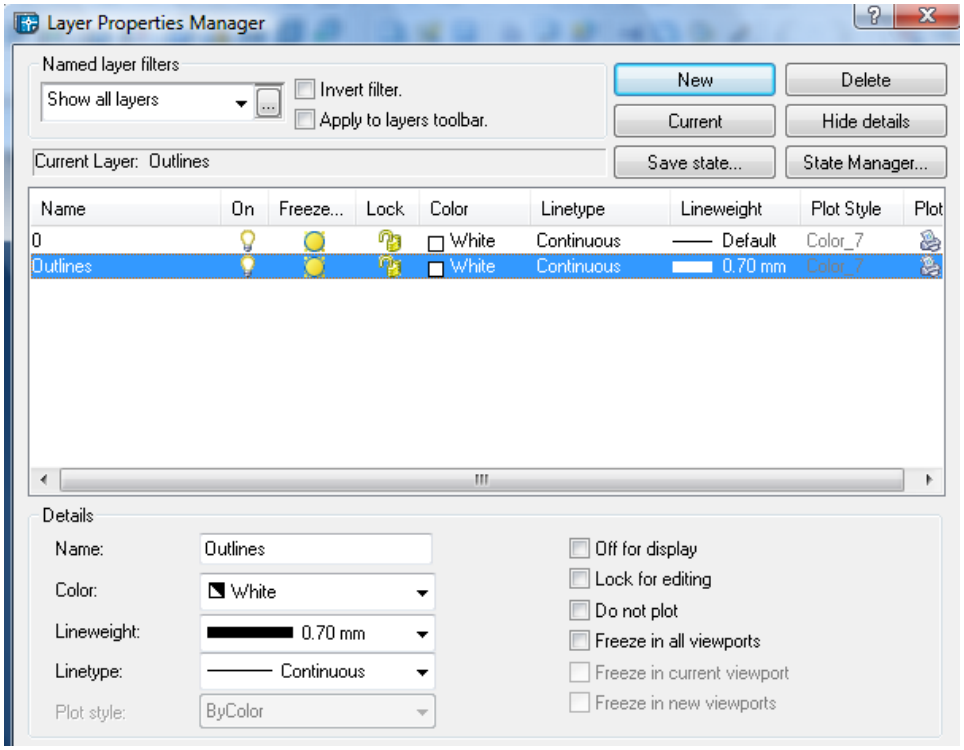


2. Click ***New*** so that a new layer is listed and replace the default name ‘layer 1’ with a more meaningful name.

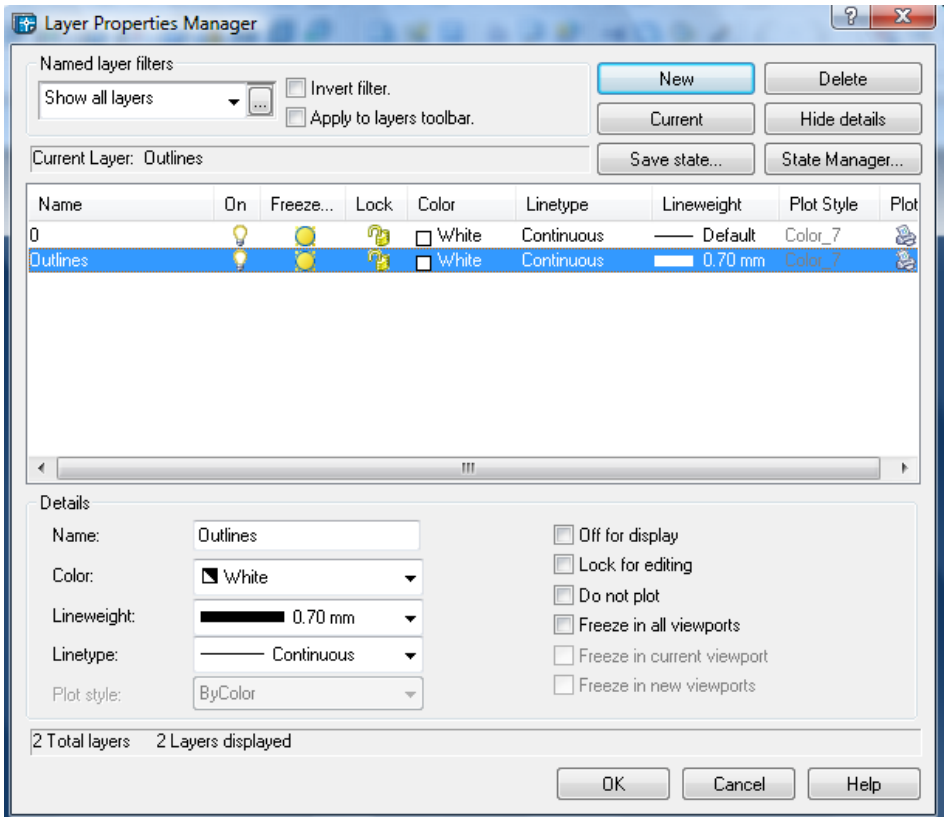


3. With the toggles ***On, Freeze, Lock*** and ***Plot*** click on the icon or the checkbox in the Details area to switch them on or off.

4. To set the ***Properties,*** click on the icon to open the related dialog box, or open the drop-down lists in the ***Details*** area to select an option there. The example below has created a layer used to create outlines and follows the ***BS 308 Llinetype*** and ***Lineweight*** specifications.



5. Click ***OK*** or close the ***Layer Properties Manager*** dialog box when finished.



LAYER PROPERTIES IN THE LAYER TOOLBAR

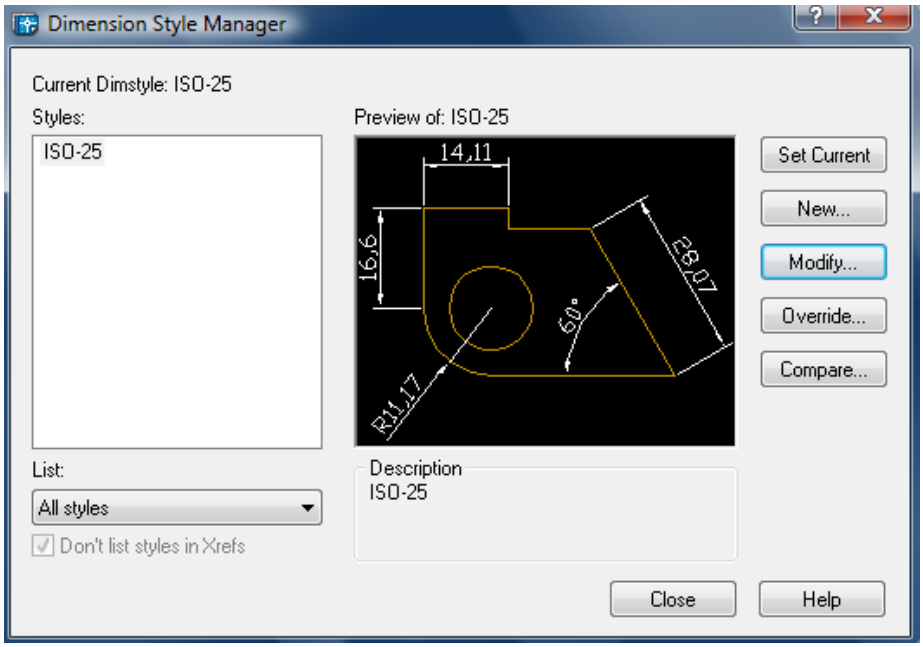
The main part of the Layers toolbar is a drop-down list where you can see and control the key properties of layers.

- ***Freezing:*** This makes layers invisible and when a layer is ***frozen***, AutoCAD completely ignores it when regenerating and redrawing a model. The layer can be ***thawed*** to bring it back into active use.
- ***On/Off:*** This toggles the visibility of a layer and when turned off a layer is not displayed or plotted. It is used to hide layers on a temporary basis.
- ***Lock:*** This prevents objects on a layer from being edited or deleted.
- ***Colour:*** This shows the colour for lines and hatches on the layer.

FORMATTING DIMENSION STYLE

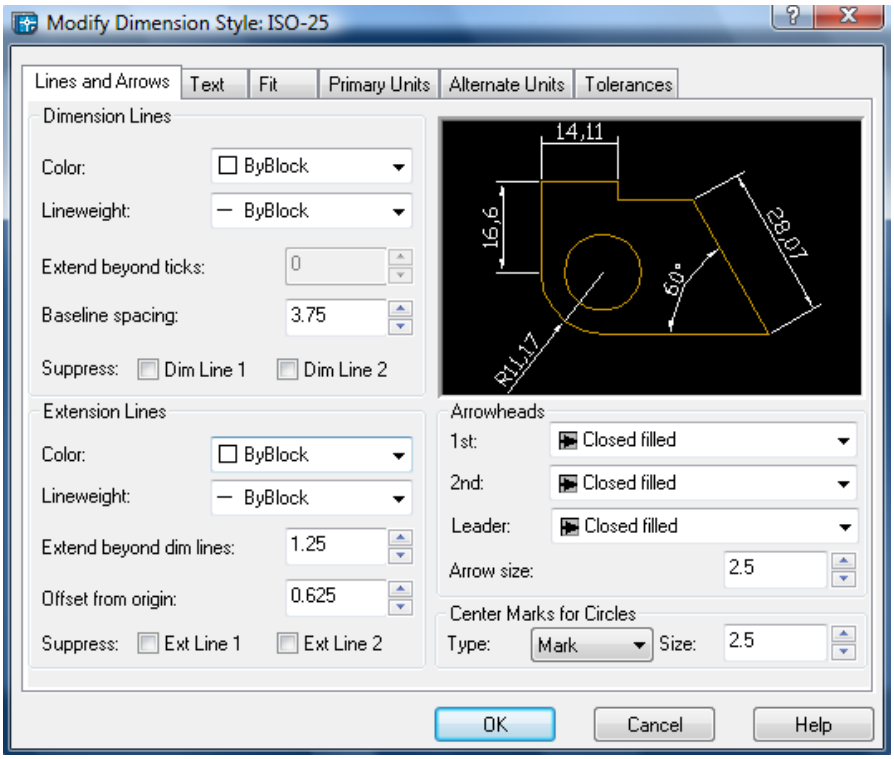
The style, size, colour and position of dimension lines, arrows and text can be controlled to conform to our chosen standard. To do this:-

1. Open the ***Format*** menu and select ***Dimension Style*** to open the ***Dimension Style Manager*** dialog box.



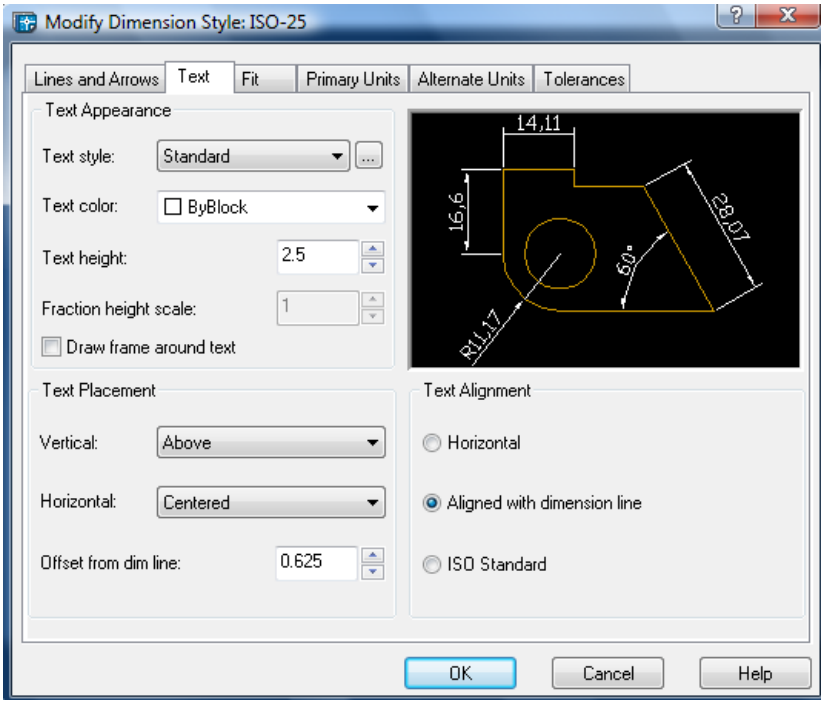
2. Highlight a style and click ***Modify.*** The ***Modify Dimension Style*** dialog box will open. Work through the tabs setting them according to our chosen standard and click ***OK*** at the end.

- ***Lines and Arrows:*** This controls the length and colour of dimension and extension lines and allows the suppression of the display of any lines.

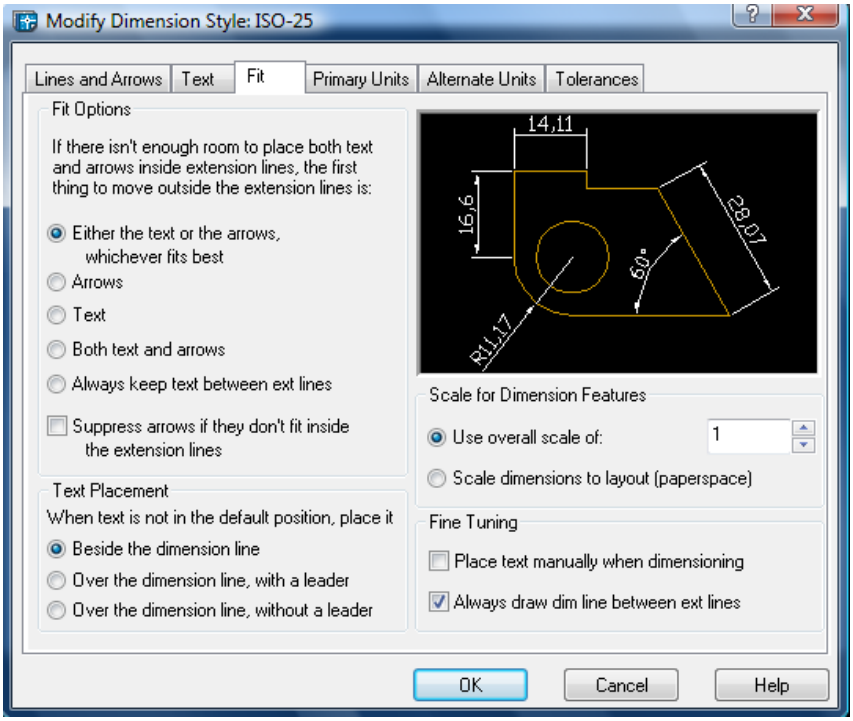


It also sets the style of arrowheads and the placing and size of centre marks and the arc length symbol.

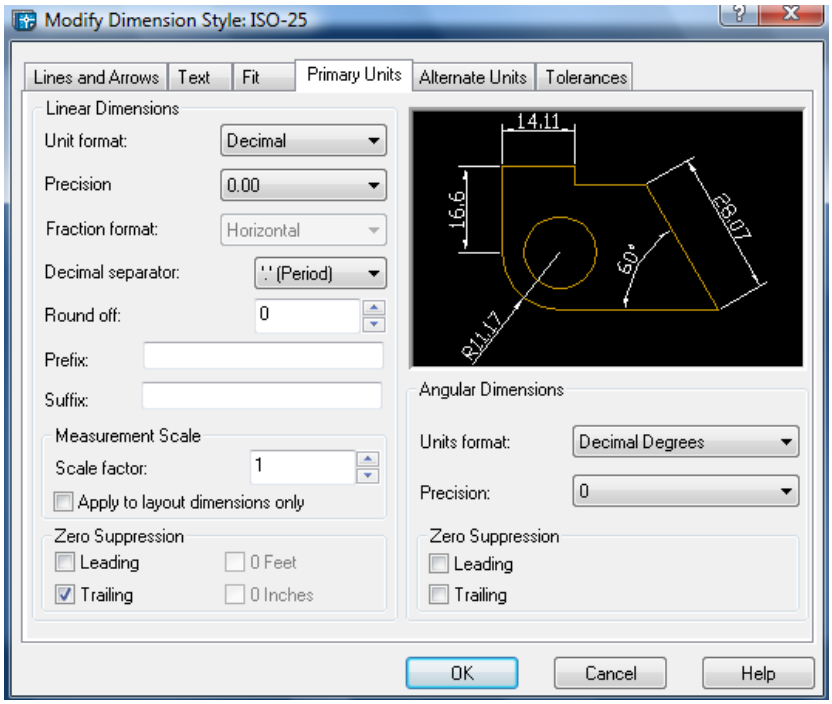
- ***Text:*** This controls the style (font and formatting),size, colour, position and alignment of text.



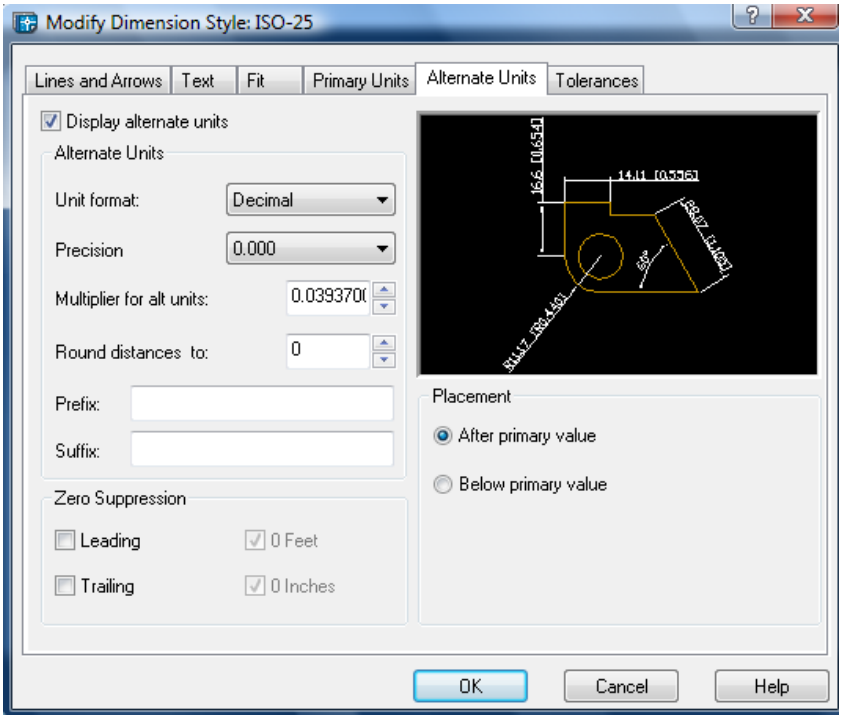
- ***Fit:*** This specifies what to do when there is not enough room for the text and arrows on dimension lines. Either can be omitted or the text can be moved beside or over the line.



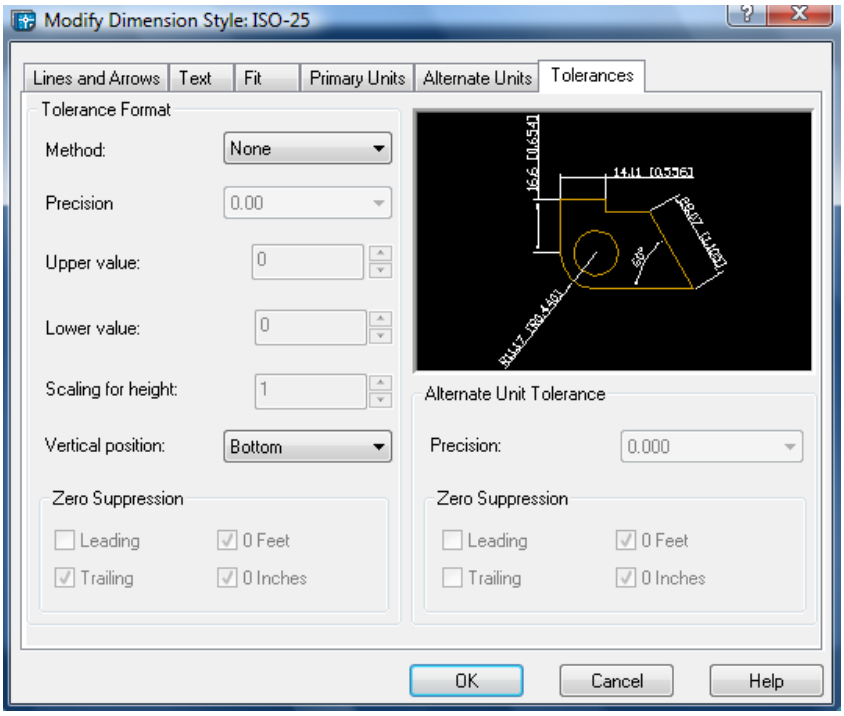
- ***Primary Units:*** This is used to set the format and accuracy of the values for the normal linear and angular dimensions.



- ***Alternate Units:*** Used to display alternate units if required e.g. feet and inches on a metric drawing. The display can be turned on/off and the format set as well as the relationship to the primary units.

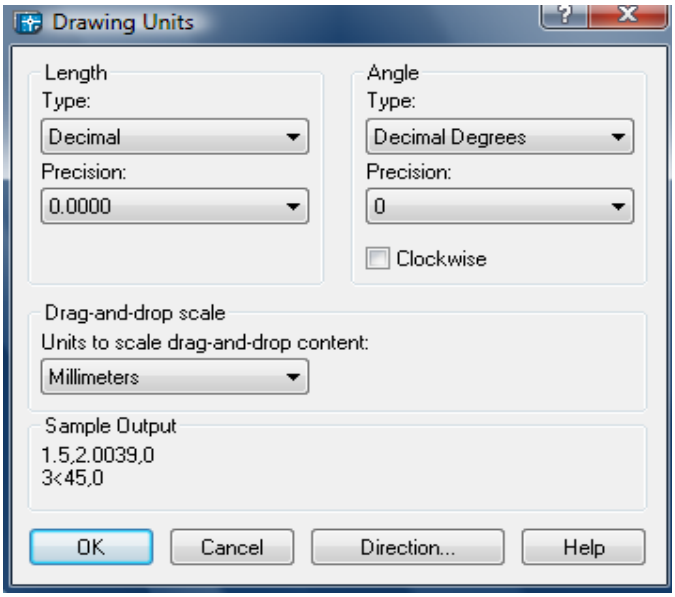


- ***Tolerances:*** This is used when tolerances are to be displayed, with the same or different upper and lower values.



FORMATTING DRAWING UNITS

1. Open the ***Format*** menu and select ***Units***....
2. At the ***Drawing Units*** dialog box, the ***Length*** and ***Angle*** units should be set. Our standards dictate we use Decimal and Decimal Degrees.



3. Units to scale should be in millimetres or metres to conform with our standards. .

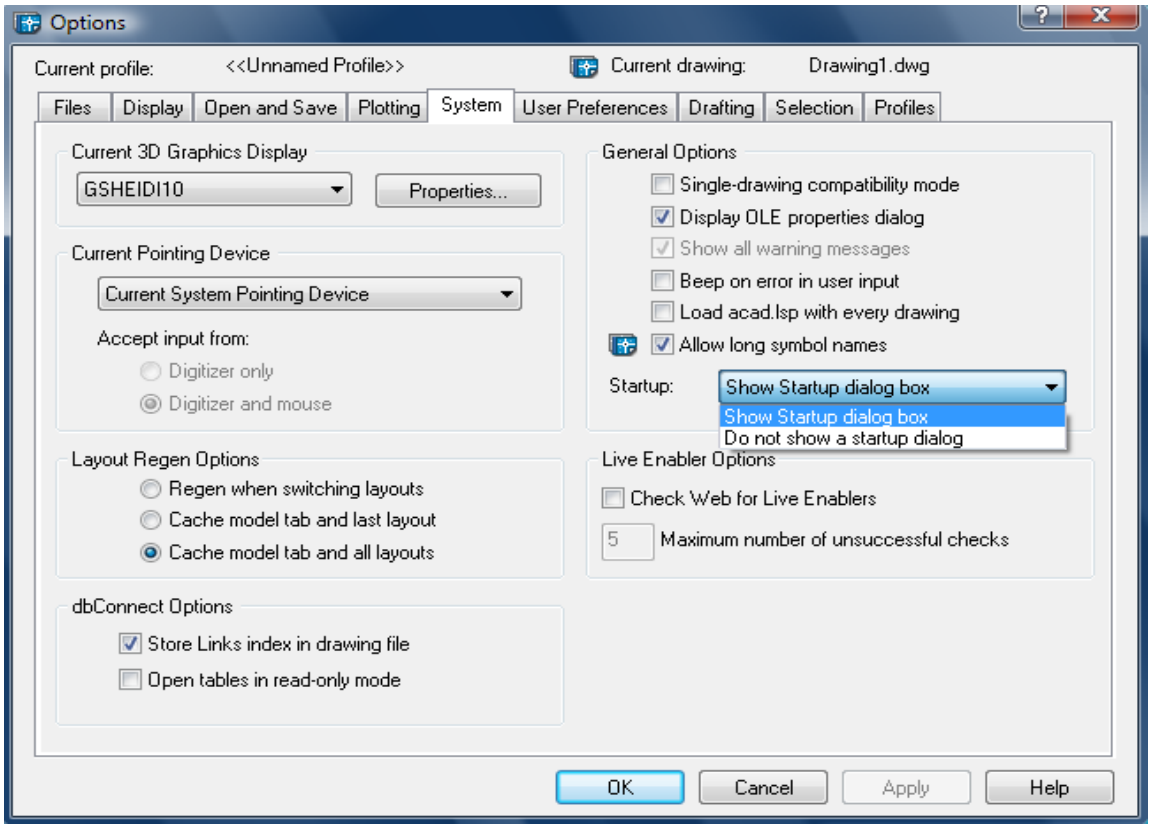
4. ***Precision*** determines how accurately values are displayed. Set a level and click ***OK***.

CHAPTER 4

STARTING AND SETTING UP DRAWINGS

There are three ways to start a new drawing and two of them depend on the ***Startup*** setting in the ***Options*** menu. To set it:-

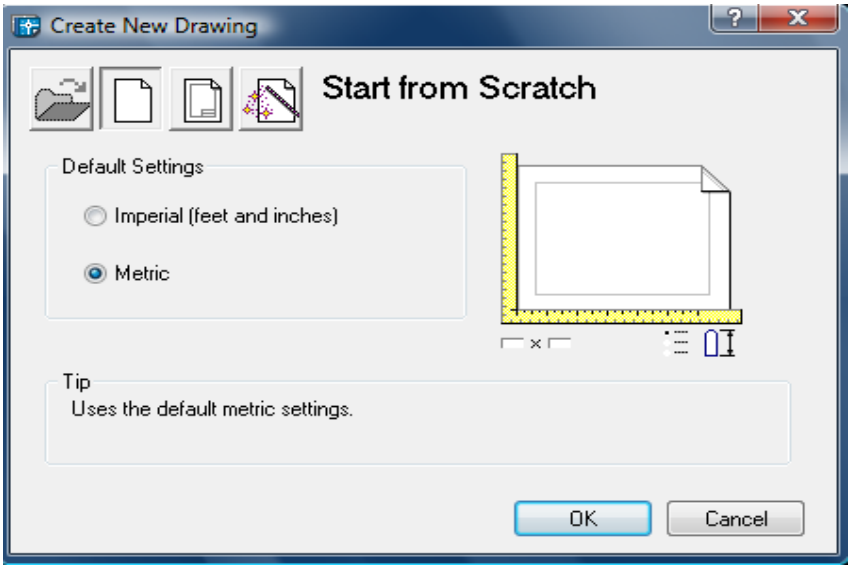
1. Open the Tools menu and select options...
2. Go to the System tab.
3. In the ***General Options*** area, at the top right, drop down the ***Startup*** list and select *show startup dialog box*.



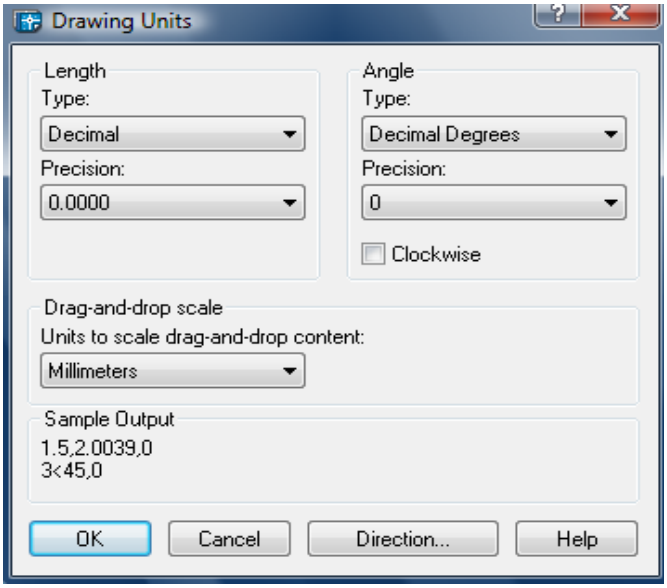
If the Startup dialog box is turned on, drawings can be started from templates or wizards, or from scratch. If it is off, you can only start from a template. There are different templates for a range of grids and information boxes.

STARTING FROM SCRATCH

5. Clickthe ***New*** button or select ***New*** from the ***File*** menu.

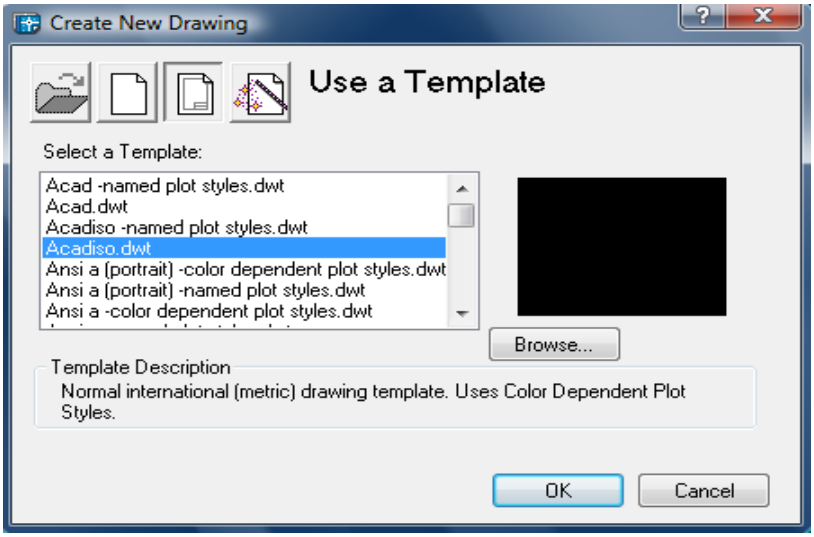


6. At the ***Create New Drawing dialog*** box, click the ***Start from scratch*** button.
7. Select your ***Default settings*** – ***Imperial*** or ***Metric*** (metric is used in Kenya).
8. Click ***Ok***.
9. Open the ***Format*** menu and select ***Units***....
10. At the ***Drawing Units*** dialog box, the ***Length*** and ***Angle*** units should be Decimal.



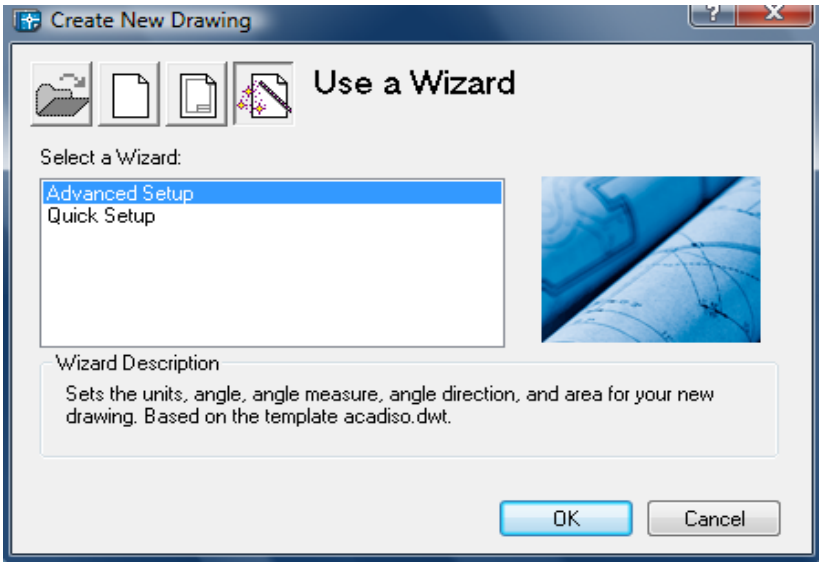
11. Units to scale should be in millimetres or metres.
12. ***Precision*** determines how accurately values are displayed. Set a level and click ***OK***.

STARTING FROM A TEMPLATE



1. At the ***Create New Drawing dialog*** box, click the ***Use a Template*** button.
2. Select the template wanted. (Acadiso.dwt isthe normal standard template normally used).
3. Click the ***OK*** button.

STARTING USING THE WIZARD



1. At the ***Create New Drawing dialog*** box, click the ***Use a Wizard*** button.
2. Select Advanced Setup andclick OK.
3. Select the ***unit of measurement*** and ***precision*** and click ***Next*** . (Normally Decimal)

4. Select the ***angle of measurement*** and ***precision*** and click ***Next*** . (Normally Decimal Degrees)

5. Select the ***direction*** to start ***angular measurements***.

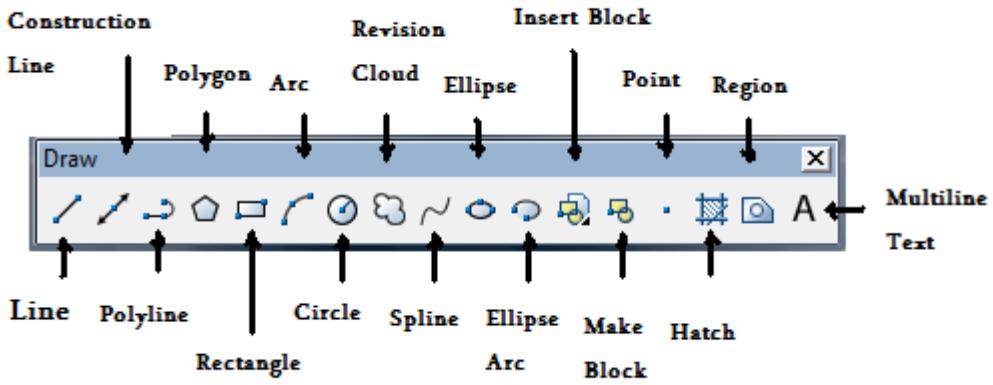
6. Select the ***orientation*** for ***angular measurements***.

7. Select the ***drawing limits*** area. Default is 420 by 297 mm for A3 paper output. In the case an A4 paper output is required paper size should be set to 210 by 297 mm.

CHAPTER 5

THE DRAW COMMANDS

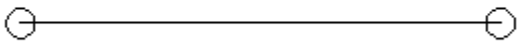
These are commands that are used in the creating of drawings. They are obtained from the ***Draw Toolbar*** that is as shown below.



THE LINE TOOL

This tool can be used to draw a single line or a continuous sequence, with the endpoint of one being the start point of the next.

1. Click the ***Line*** tool .
2. Click on the drawing area where you want the line to start.
3. Drag across the screen in the required direction and click where you want the line to end, then press ***Enter***. An easier method is to type in the required length into the Command Line and press ***Enter*** after the direction has been specified**.**



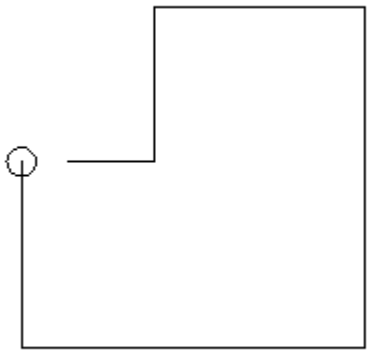
NB

When constructing drawings in Auto CAD. It is advisable to toggle between ***Snap, Ortho, Osnap*** and the other functions in order to make constructing easier. They're uses are explained in Chapter 2.

POLYLINE TOOL

This tool is similar in use to the Line tool however when it is used in a continuous sequence it forms a single object – clicking anywhere on a Polyline selects the whole set. Line tool drawn lines on the other hand are always separate objects. To use this tool:

1. Click the ***Polyline*** tool .
2. Click at the point you want to start the line and drag to the required length or type the required length into the Command Line and press ***Enter.*** Repeat this procedure as necessary.
3. Press ***Enter*** or Right - Click to end.



7

POLYGON TOOL

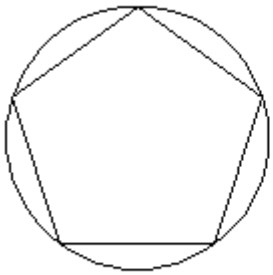
A polygon is a shape with any number of equal sides. This tool can create squares, triangles, pentagons or any regular shape of up to 1024 sides. This tool can be used in two ways.

To define a polygon by length of an edge:

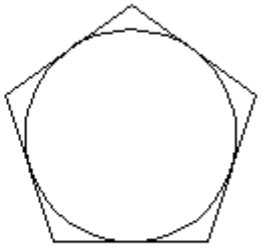
1. Click the ***Polygon*** tool .
2. Type the number of sides required.
3. Type 'E' to select edge mode.
4. Specify the point at one end of an edge.
5. Drag to draw the line – the polygon, based on this, will take shape. Click once to confirm the polygon.

To define a polygon by its centre and radius:

1. Click the ***Polygon*** tool and type the number of sides.
2. Specify the centre point.
3. Type 'I' to select Inscribed, or 'C' for Circumscribed mode.
4. Type the radius or use the mouse to drag the polygon to size and rotate it as required, clicking when it is in the right position.



Circumscribed

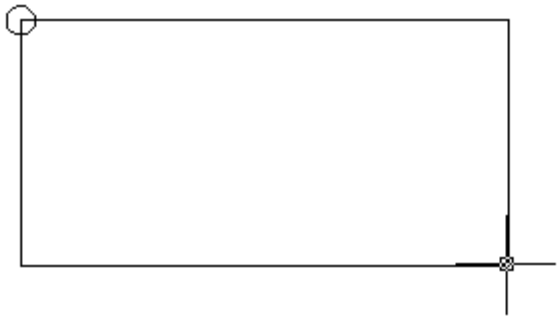


Inscribed

RECTANGLE TOOL

To use this tool:

1. Click the ***Rectangle*** tool .
2. Click the point you would like to place a corner.
3. Drag the rectangle till it is of the required size and click again to confirm.

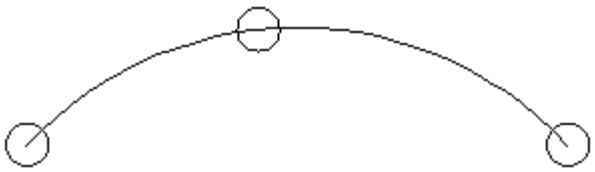


ARC TOOL

This creates an arc from the start, end and another point anywhere else on the arc. The arc will be drawn clockwise or anticlockwise, depending upon the position of the points.

To draw an arc from three points:

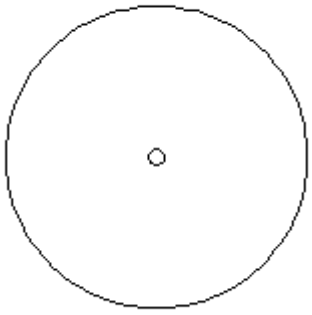
1. Click the ***Arc*** tool .
2. Specify the start point.
3. Specify another point anywhere on the arc – a straight line will (temporarily) link it to the start point.
4. Specify the end point.



THE CIRCLE TOOL

To use this tool:

1. Click the ***Circle*** tool .
2. Pick or type the centre coordinates.
3. Type or drag and click to set the radius.



SPlINE TOOL

This tool is used to draw a continuous line with multiple curves. The line is defined largely by the points on the cusps of the curves. The curves at the start and end are defined separately afterwards.

To use this tool:

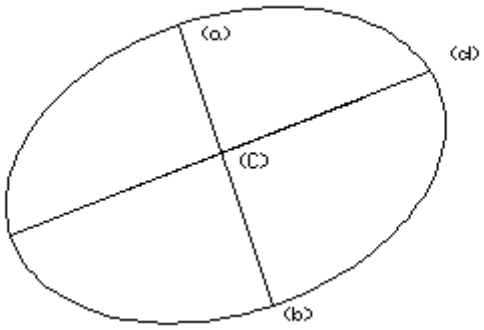
1. Click on the ***Spline*** tool .
2. Click or type the coordinates to specify the start point.
3. Specify the points to locate the curves along the line.
4. Press ***Enter*** at the end.
5. A straight line will appear, connecting to the start point. Move this to form the first curve. Repeat for the end curve.

ELLIPSE TOOL

An ellipse has two axes that cross at right angles. The shape is defined by the length of those axes, and their angle to the grid.

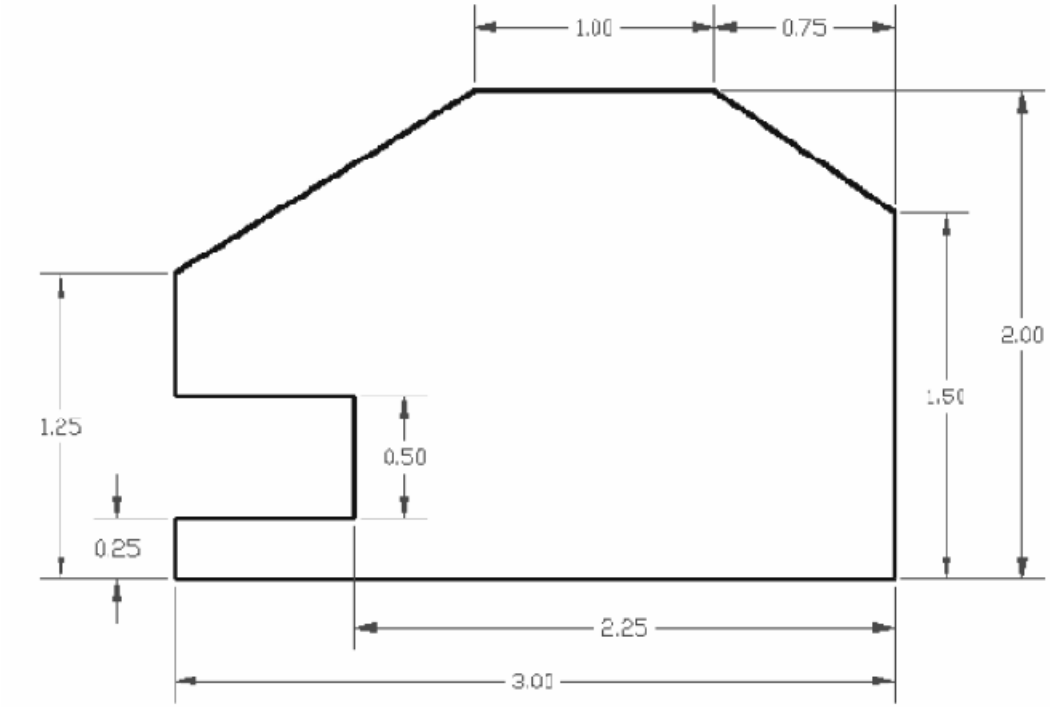
To define an ellipse:

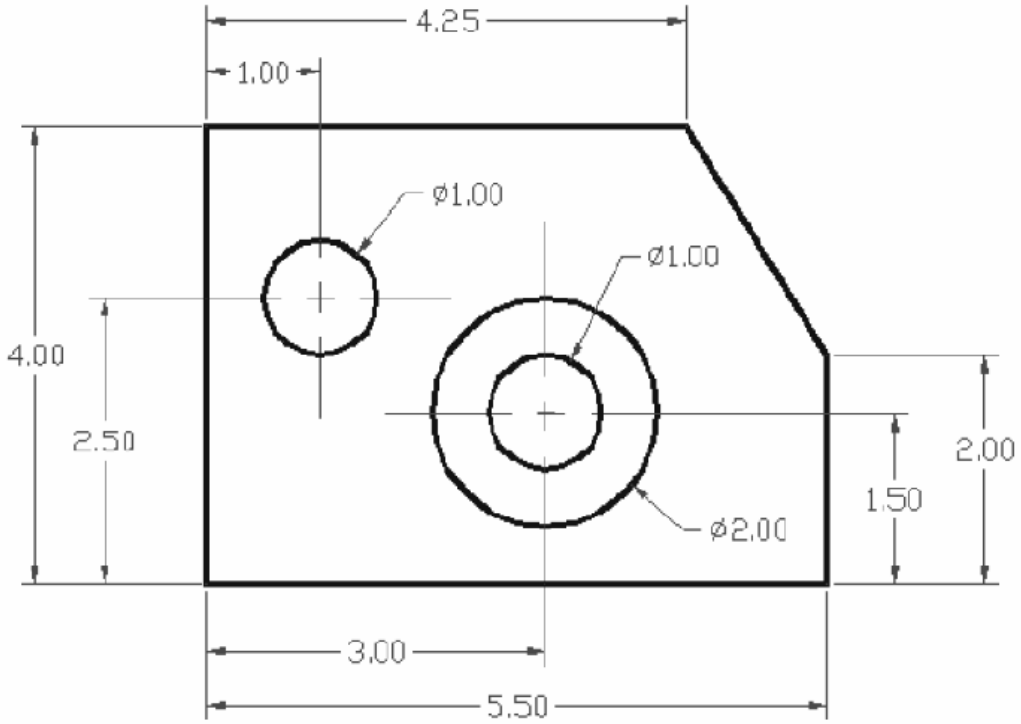
1. Click on the ***Ellipse*** tool .
2. Specify the position of the start point of an axis.(a)
3. Drag and click or type the coordinates to set the length and angle of the axis.(b)
4. Specify the length of the other axis, from the centre (c) to the edge (d) – its angle will be 90 degrees to the first.

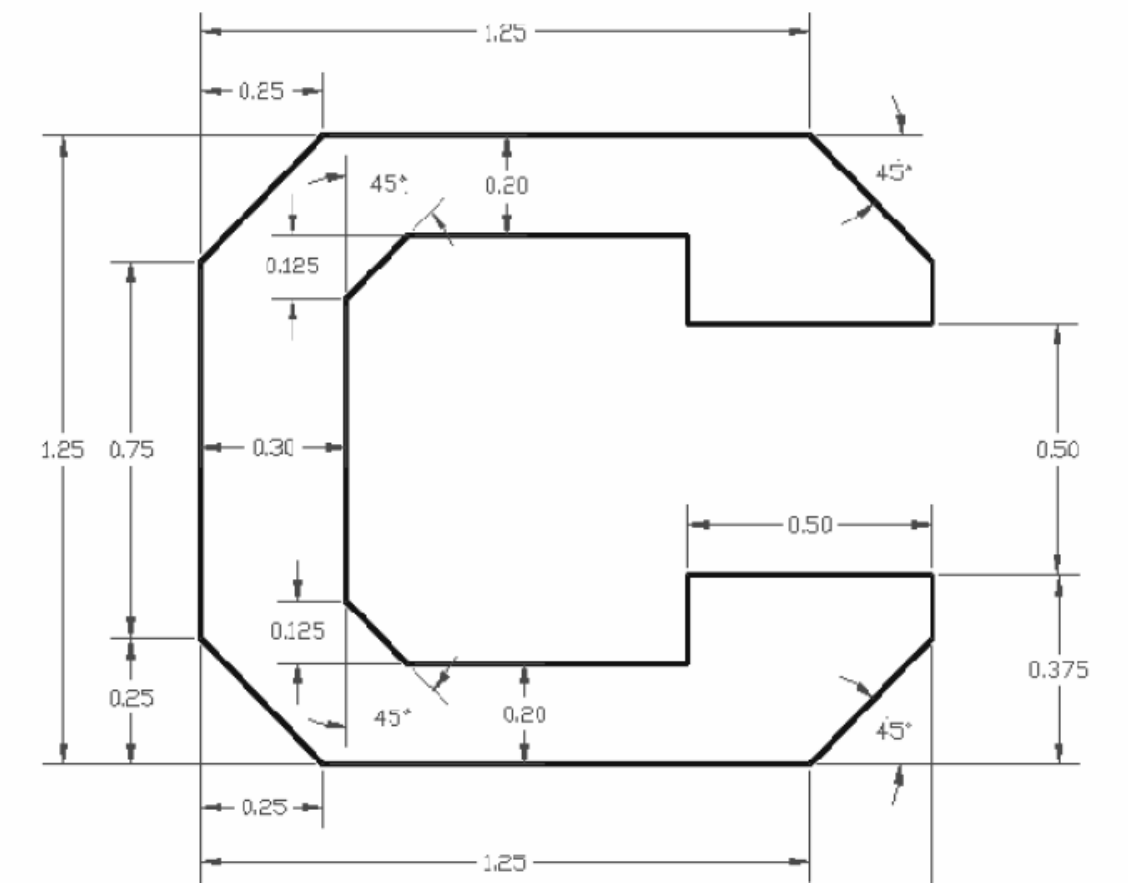


PRACTISE EXERCISES

Use the above tools to create the following practise drawings. All dimensions are in inches. (Do not forget to format units).



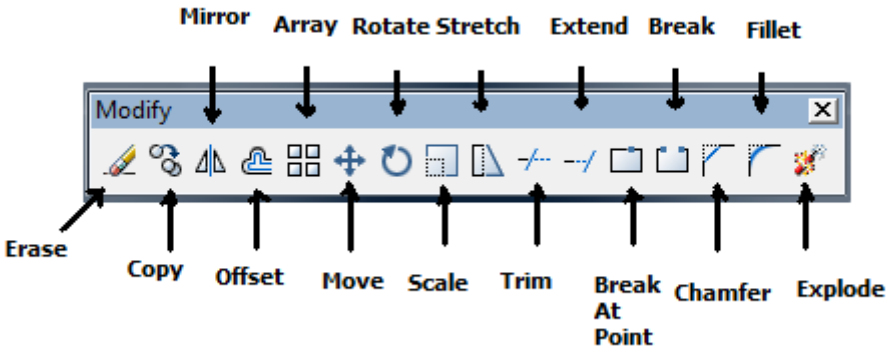



1.25
0.25
45°
0.20
45°
0.125
1.25
0.75
0.30
0.50
0.50
0.125
0.375
0.25
45°
0.20
45°
0.25
1.25

CHAPTER 6

THE MODIFY COMMANDS

The modify commands are tools found on the ***Modify Toolbar*** and are key tools needed for manipulating objects. The ***Modify Toolbar*** is shown below.

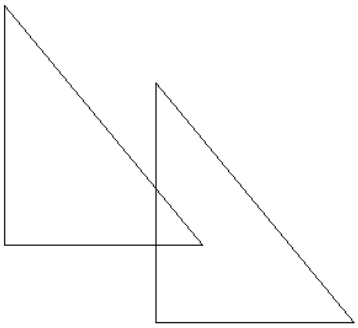


ERASE TOOL

1. Select the objects you want to remove.
2. Click the ***Erase*** tool .

COPY TOOL

1. Select the objects you want to make copies of.
2. Click the ***Copy*** tool .
3. Specify a base point which is used to place the copy at a certain required location.



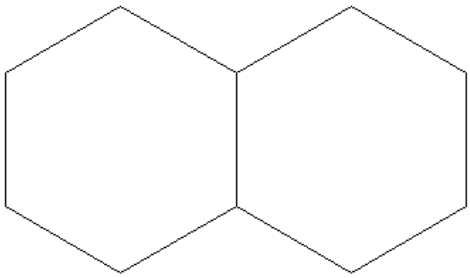
NB: By default only one copy is made at a time. If several are required the multiple option at the start of the command can be switched on.

MIRROR TOOL

This tool produces a mirror image, allowing the creation of a symmetrical object by drawing only half of it – or even a smaller fraction.

To create a mirror image:

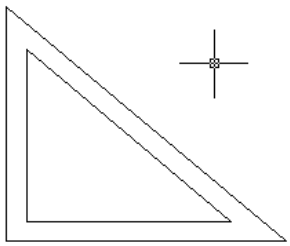
1. Click the ***Mirror*** tool , select the objects and press ***Enter.***
2. Pick the co-ordinates of one point on the mirror line.
3. Pick the second point to fix the line.
4. The command line will prompt:
   Delete source objects? [Yes/No] <N> :
5. Type 'Y' to delete the object, or press ***Enter*** to accept the default (No).



OFFSET TOOL

Offset creates copies of an outline within or outside the source shape. You must start by selecting the tool (or command) and specify the offset distance before selecting the object.

1. Select the ***Offset*** tool .
2. Type the offset distance into the Command Line.
3. Click on the source object.
4. Click inside or outside of the object to tell AutoCAD whether to make an inner or outer offset.
5. Press ***Enter*** or right – click to end.

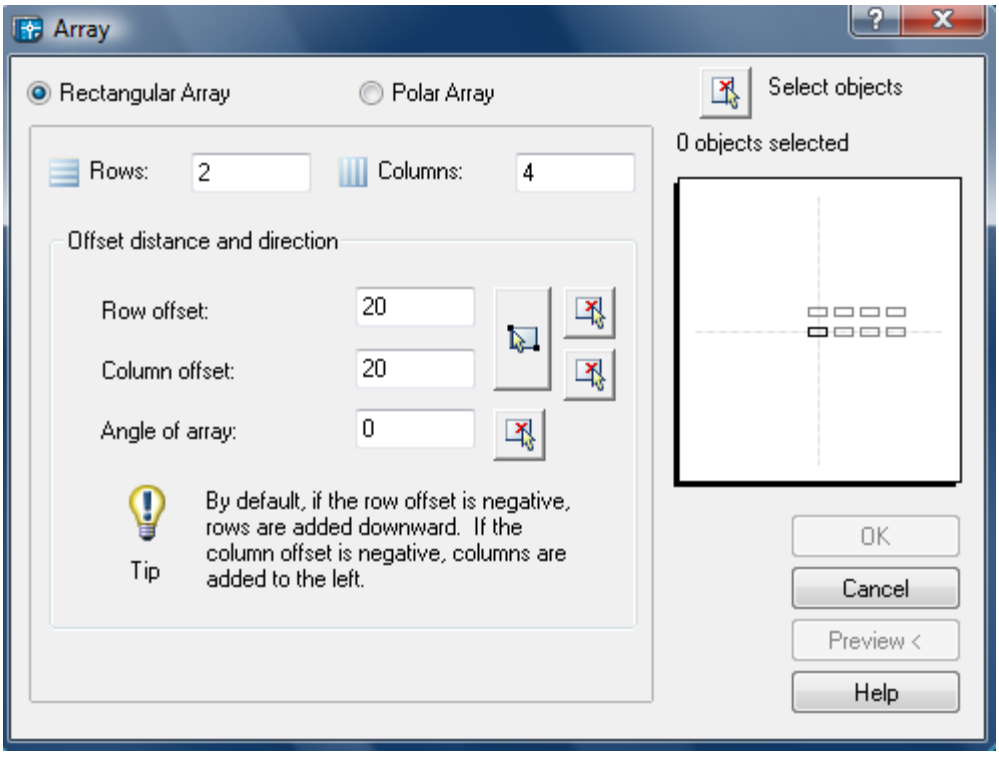


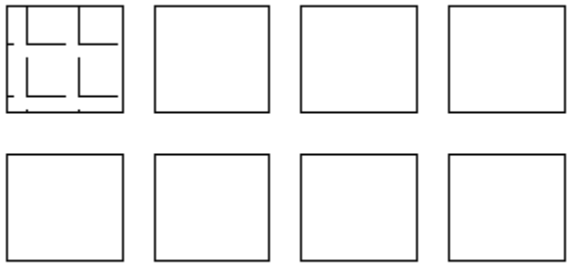
ARRAY TOOL

This creates a regularly spaced array of copies. The array can be a rectangular grid or a polar pattern, radiating around a central point.

To create a ***rectangular arra***y:

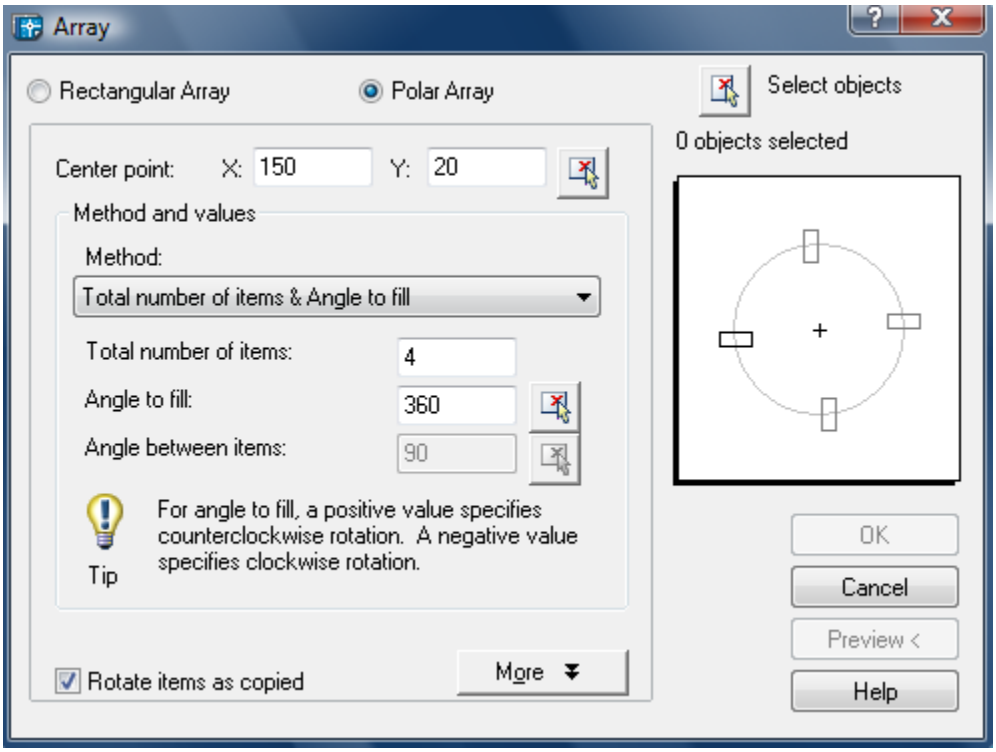
1. Click the ***Array*** tool , select the objects and press ***Enter.***
2. Select the ***Rectangular Array*** option at the top of the ***Array*** dialog box.
3. Set the number of ***Rows*** and ***Column offsets*** – the distance between the same points on two copies.
4. The ***Angle of array*** tilts the array from the horizontal. Set a value if required.

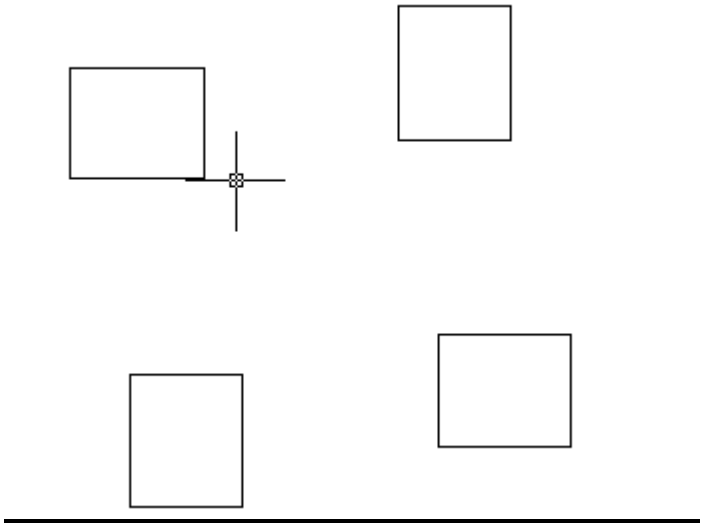




To create a ***Polar array***:

1. Start as for the ***Rectangular array,*** but select the ***Polar Array*** option in the ***Array*** dialog box.
2. Type the ***Center point*** coordinates, or click and pick the point.
3. Set the ***Total number of items*** and the ***Angle to fill.***
4. Tick or clear the ***Rotate items as copied*** checkbox on the bottom left, as required.
5. Click ***OK.***

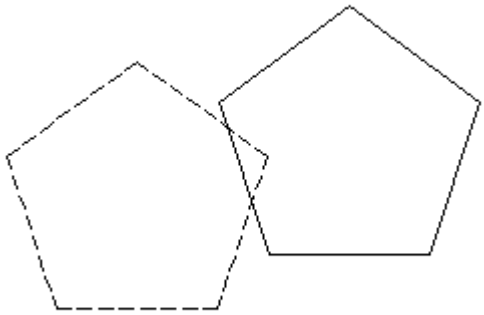




MOVE TOOL

The move tool is used to move objects with greater accuracy.

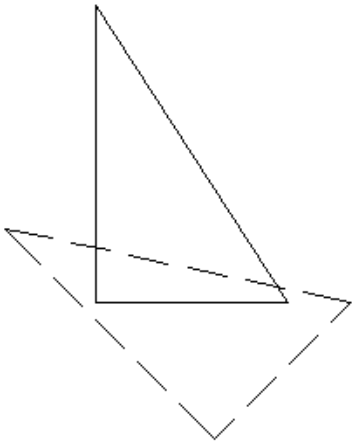
1. Click the ***Move*** tool, select the objects and press ***Enter.***
2. Pick a base point in or near the objects.
3. Type the coordinates or pick where you want to move the base point to.



ROTATE TOOL

This is used to rotate an object about a point within its shape or outside of it.

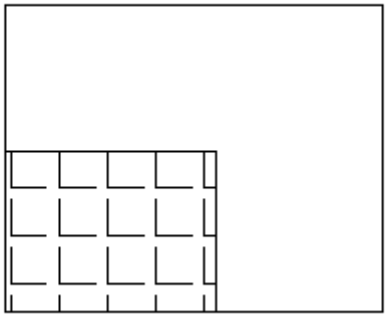
1. Click the ***Rotate*** tool, select the objects and press ***Enter.***
2. Type the coordinates or pick the point to rotate around.
3. Type the angle, or use the mouse to rotate the object.



SCALE TOOL

This tool makes an object uniformly larger or smaller by changing all the coordinates by the same factor and in relation to a given point.

1. Click the ***Scale*** tool, select the objects and press ***Enter.***
2. Pick a base point within the object to change its size without moving it, or outside to change the size and position.
3. Type the scale factor in the Command Line.



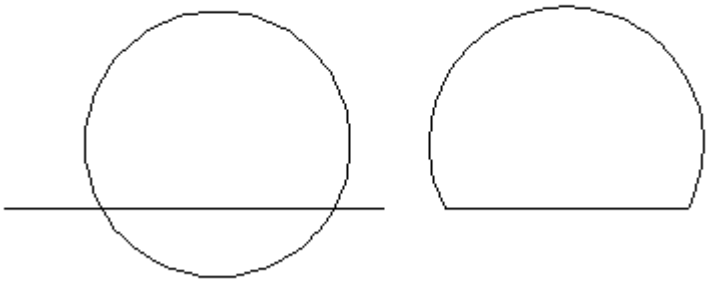
TRIM AND EXTEND TOOLS

These are used to trim off excess or extend lines to make an exact fit. Trimming can be done to where a line meets an existing line or newlines can be added to act as a ‘cutting edge’.

Similarly, when extending lines, an existing or a temporary line can act as the boundary edge.

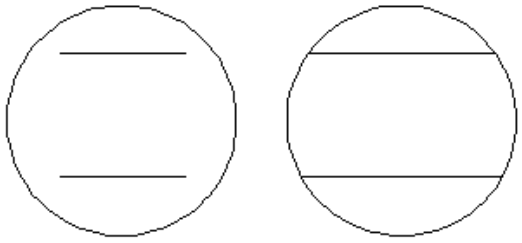
To trim a line or shape:

1. If necessary, draw the cutting edge lines.
2. Click the ***Trim*** tool .
3. Select the lines to act as the cutting edge and press ***Enter.***
4. Click on the lines or shapes where they project beyond the cutting edge.
5. Delete the cutting edge if it has no further purpose.



To extend lines:

1. If necessary, draw the boundary edge lines.
2. Click the ***Extend*** tool .
3. Select the lines to act as the boundary edge and press ***Enter.***
4. Click on the lines to extend to meet the boundary edge.
5. Delete the boundary edge if it has no further purpose.

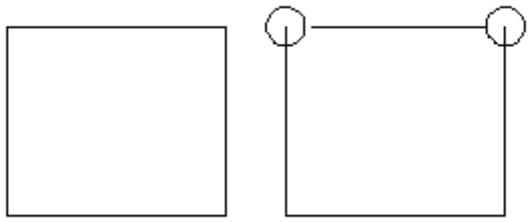


BREAK TOOL

This tool has two versions. ***Break*** cuts a section out of a line or shape, ***Break at a point*** cuts through a line or a shape, creating two lines though the ends still meet.

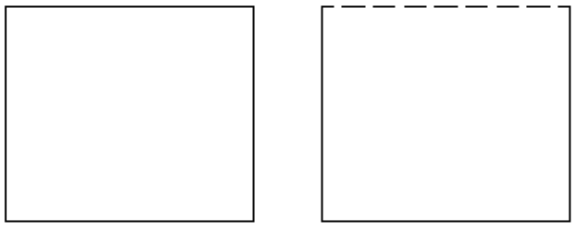
To break a line:

1. Select the ***Break*** tool .
2. Click on the line at the point where you want to break it – this selects the line and the break point.
3. Click where you want the second breakpoint.



To break at a point:

1. Select the ***Break at point*** tool .
2. Click on the line or shape to select it.
3. Click where you want the breakpoint.



JOIN TOOL

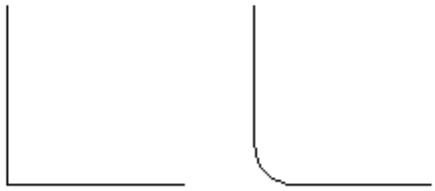
Join will put back together a line, arc, circle, polyline or spline that has been broken apart. It is also used to join objects that were drawn separately in the first place though two lines can only be joint if there is direct communication between the two of them.

FILLET TOOL

This tool is used to round off any corner, or draw any arc to join a pair of lines that intersect o could intersect if extended.

To make a fillet:

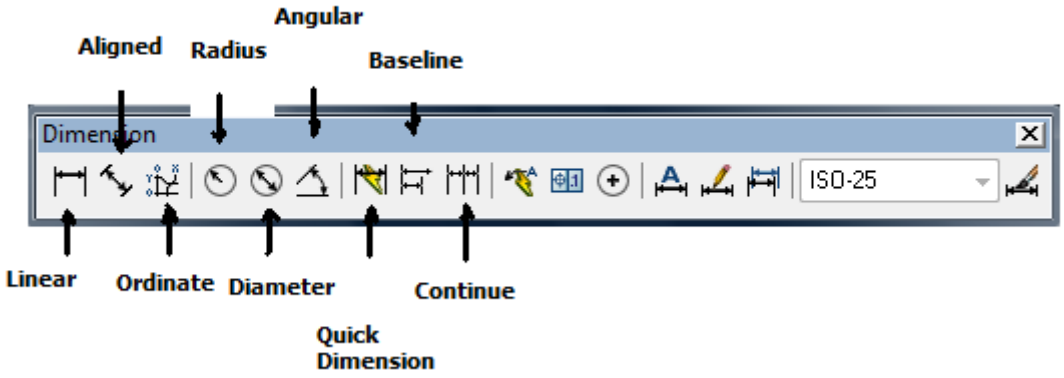
1. Click the ***Fillet*** tool .
2. Check the current settings.
3. Type ‘R’ then the value to change the Radius.
4. Type ‘T’ then the setting if you want to change the Trim mode.
5. Type ‘U’ if you want to turn on the Multiple option.
6. Select the two lines to fillet.



CHAPTER 7

DIMENSIONING

AutoCAD enables the calculation and display the dimensions of the lines, curves and angles of drawings. The size and style of the dimension text, arrows and lines can be adjusted as necessary through the ***Dimension Style dialog box.*** The ***dimension*** toolbar is shown below.

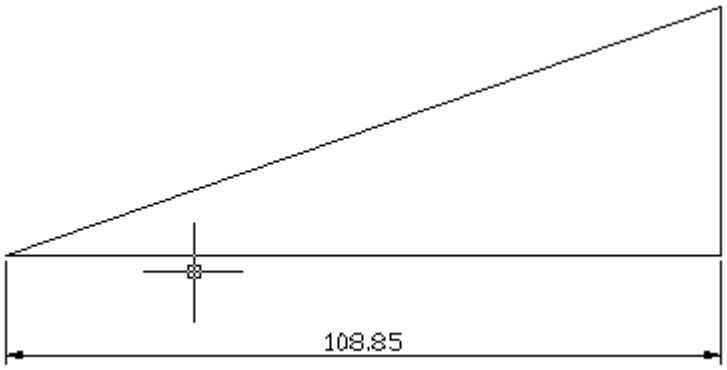


LINEAR DIMENSION

This is used on vertical or horizontal lines to give the length.

To use the tool:

1. Click on the ***Linear Dimension*** tool .
2. Click on one end of the line to be measured, then on the other – anew line will appear.
3. Pull the dimension lineout and click when it is in clear space.

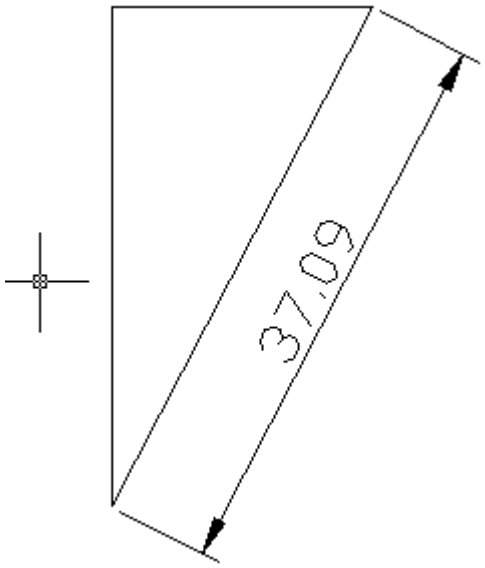


ALIGNED DIMENSION

This gives the length of angled lines, but it works equally well on horizontal or vertical ones.

To use the tool:

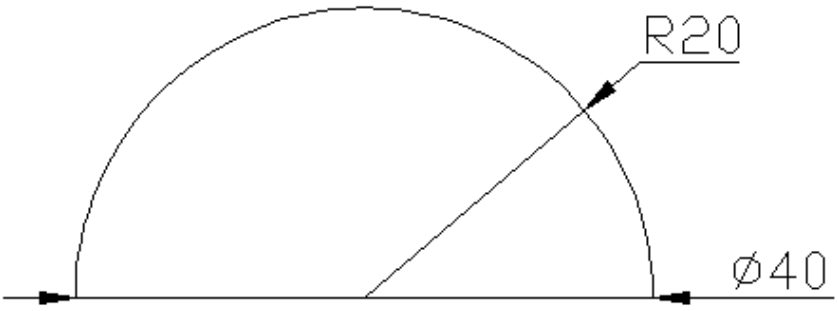
1. Click on the ***Aligned Dimension*** tool .
2. Click on one end of the line to be measured, then on the other- a new line will appear.
3. Pull the dimension line outwards from the drawing and click when it is in clear space.



RADIUS AND DIAMETER DIMENSIONS

These can be used on any arc or circle and work in the same way except that the Radius dimension line starts in the centre of the arc and the text has 'R' at the start while the diameter line runs its full width and the text is prefixed by '∅'.

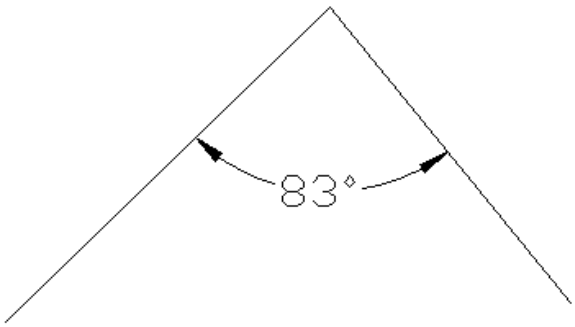
1. Click on the ***Radius*** or ***Diameter*** ***Dimension*** tool.
2. Click anywhere on the arc and drag around it to set the angle of the dimension line.
3. Draw out from the arc to set the length of the line and the position of the text.



ANGULAR DIMENSION

This tool shows the angle between two lines which do not necessarily have to meet at a vertex.

1. Click on the ***Angular Dimension*** tool .
2. Click on the first line, then on the second – a curved dimension line will appear.
3. Drag the dimension line into position.



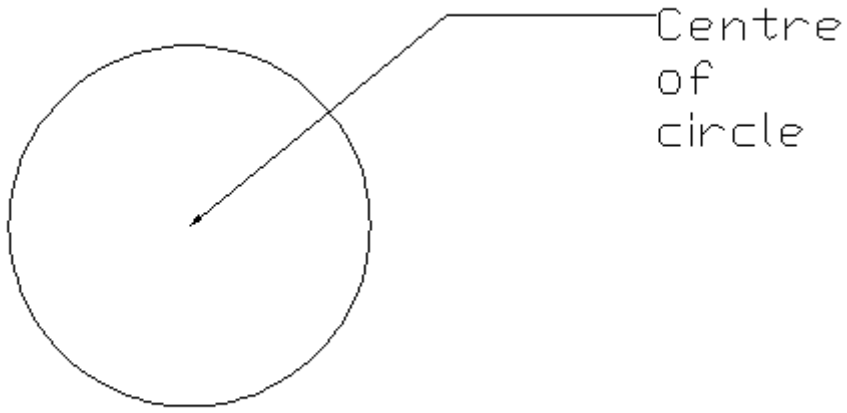
LEADERS

A leader is a multiline caption with an arrowed line pointing to a feature on the drawing.

To create a leader line:

1. Click on the ***Quick Leader*** tool .
2. Click on the object you want to label.
3. Drag and click to create a line from the drawing.
4. If a second line is required – perhaps to angle around another object – drag and click to create it.

5. Right click to end the line – drawing part of the routine.
6. The Command Line will prompt for the text width. Type a value or Right Click to accept the default value.
7. When prompted for text, type the caption into the Command Line, or right click to get the editing and formatting display.



CHAPTER 8

PLOTTING AND VIEWPORTS

You can print directly from model space, but to obtain properly scaled and professionally presented output, ***layouts*** should be used.

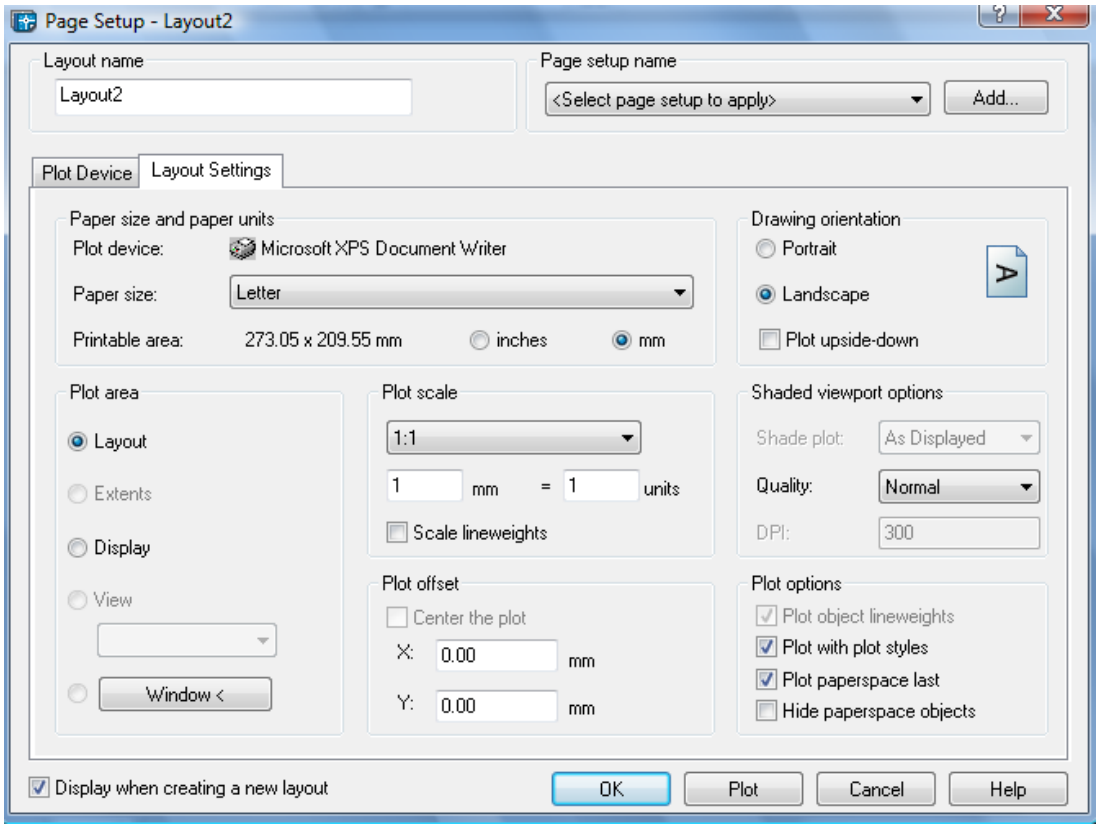
LAYOUTS

A layout is a view of model space prepared for output to a plotter or printer. It can show the whole drawing or just a part of it. It can include text, dimensions and additional drawn items that are not present in model space .e.g. a title bar.

Each layout is designed for a specific plotter/printer and printer size, and displays the drawing in a specific view.

To create a layout from scratch:

1. Click on the layout tab.



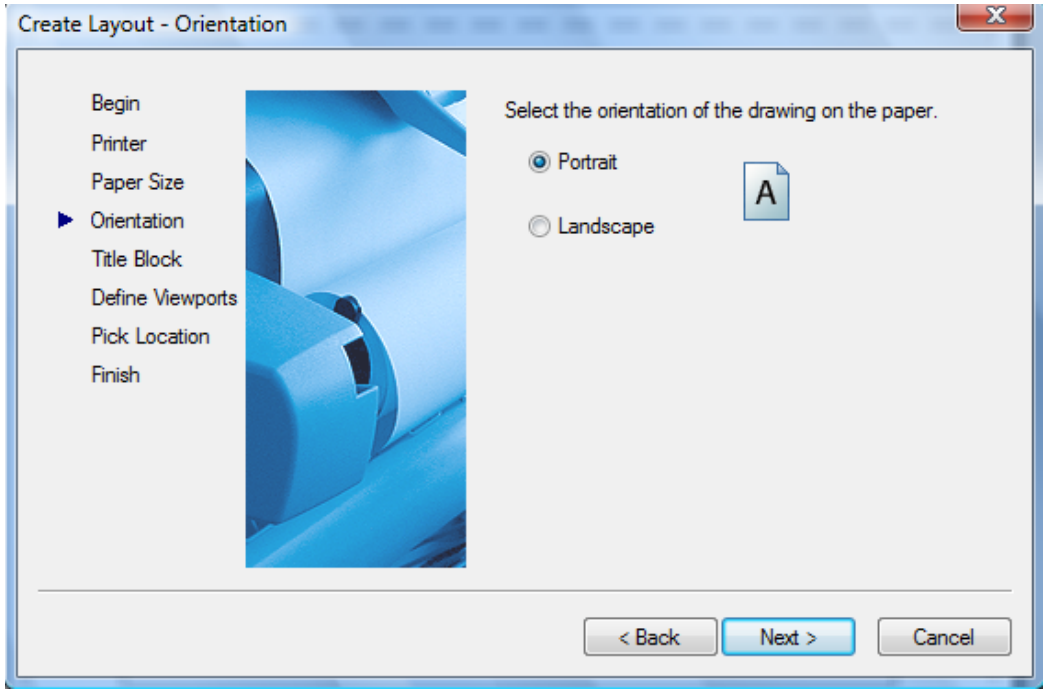
2. At the ***Page Setup*** *dialog box, first select the* **Printer/plotter.**
3. *Select the* **Paper size** and ***Drawing orientation*** as required.

4. Set the ***Plot scale*** to the design scale of the drawing. The ***Fit to paper*** option may be available.
5. Click the ***Preview*** button to see how it will look. If necessary, go back and adjust the settings.
6. Click **Ok** *to close the dialog box.*

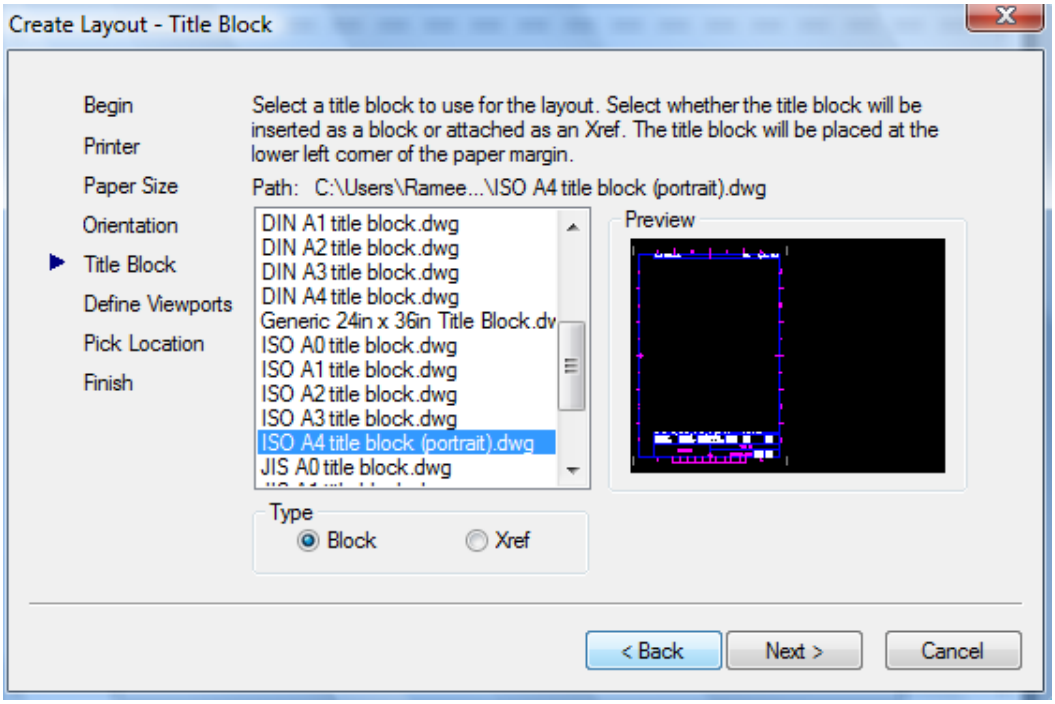
In engineering drawings it is more appropriate to create and place drawings within title blocks. These title blocks are created using the ***Layout Wizard.***

To use the wizard:

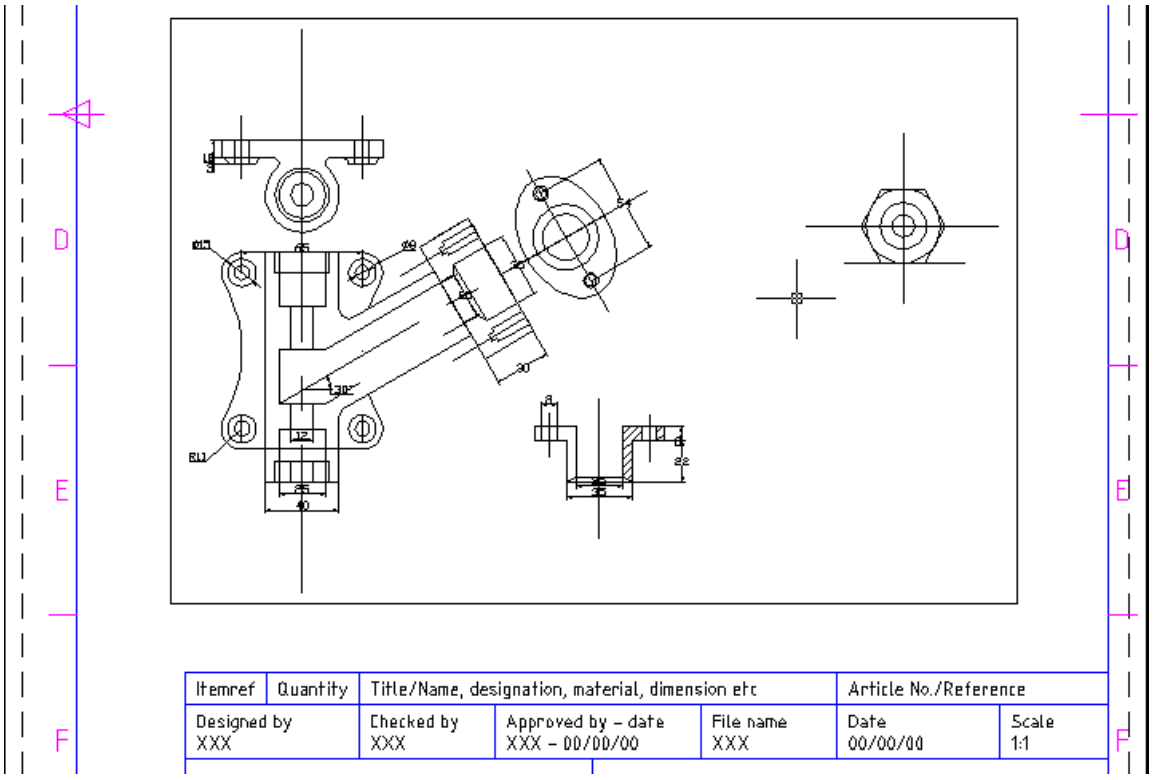
1. In the ***Tools*** menu, point to ***Wizards*** and then select ***Create Layout***.
2. Select ***Printer***, ***Paper size***, and ***orientation*** as required.



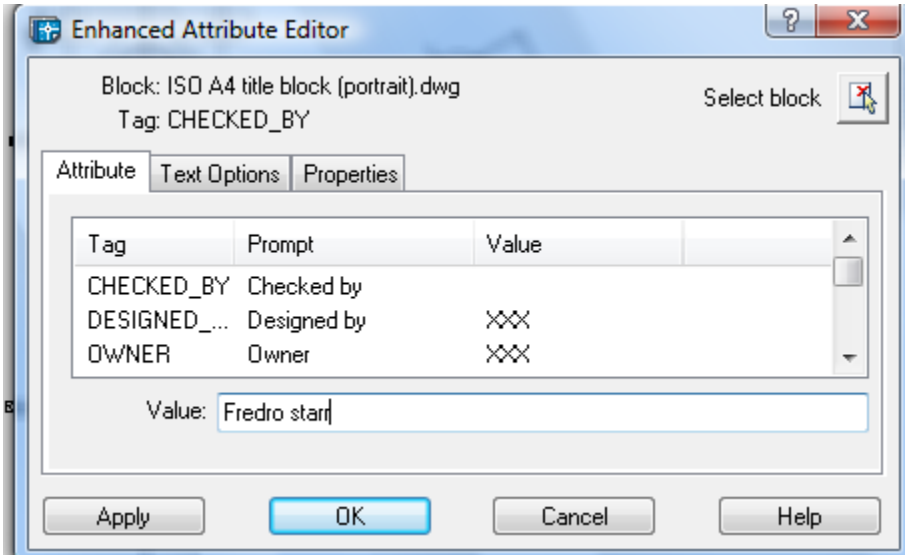
3. At the ***Title Block*** step, select a readymade block suitable for your paper size and orientation. In our case it is advised to use one of the ISO standard title blocks to conform with our standards.



4. At the ***Define Viewports*** step, select ***Single*** to use the current view.
5. At the ***Pick Location*** step, Click ***Select Location*** to go into the layout and draw a rectangle where you want the drawing. Click ***Finish***. In our example the ISO A4 title block was selected.



6. To edit the text in the title block, double click on it. The ***Enhanced Attribute Editor*** dialog box will open. Work through the tags, clicking on each in turn and typing your details in as the value. Click ***Ok*** when done.



VIEWPORTS

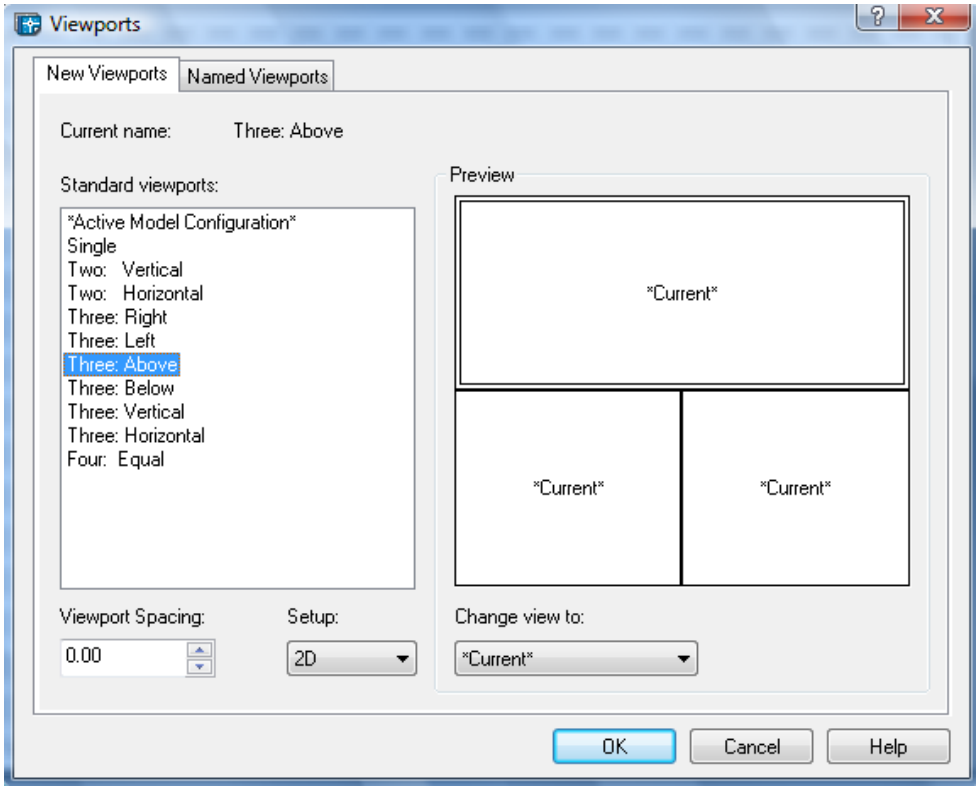
A viewport divides the screen into two or more areas so that you can look at your model in different ways at the same time. The screen can be divided into up to four viewports. You have a set of pre defined viewports to choose from or you may create your own.

To divide the screens:

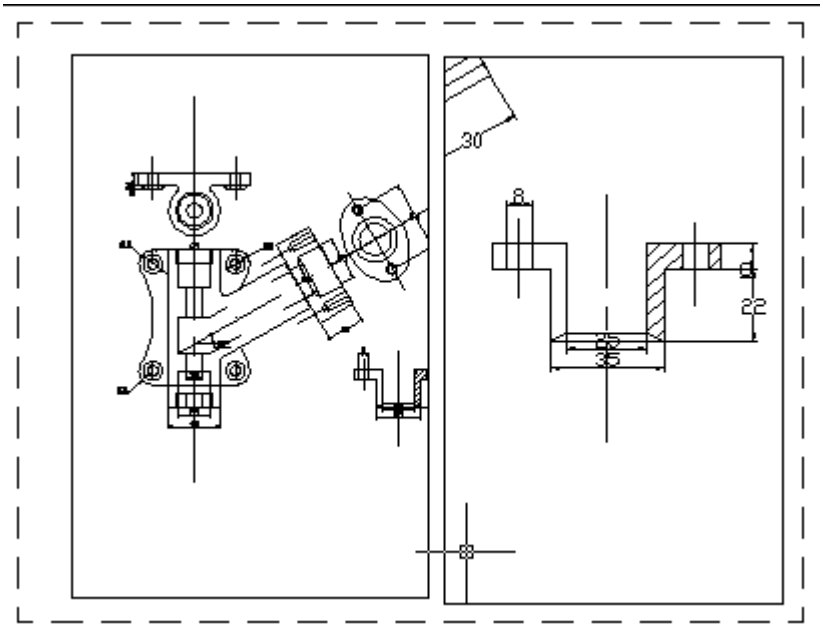
1. Open the ***View*** menu, point to ***Viewports*** and select the number of viewports.
2. Choose between ***Horizontal*** or ***Vertical*** divisions.

OR

1. Open the ***View*** menu, point to ***Viewports*** and select ***New Viewports***.
2. The ***Viewports dialog box*** will open with the ***New Viewports*** tab at the front.



3. Click on the name of a viewport to see a preview of the screen division and click ***Ok*** when a suitable layout is found. We will use a two viewport screen division as shown below.



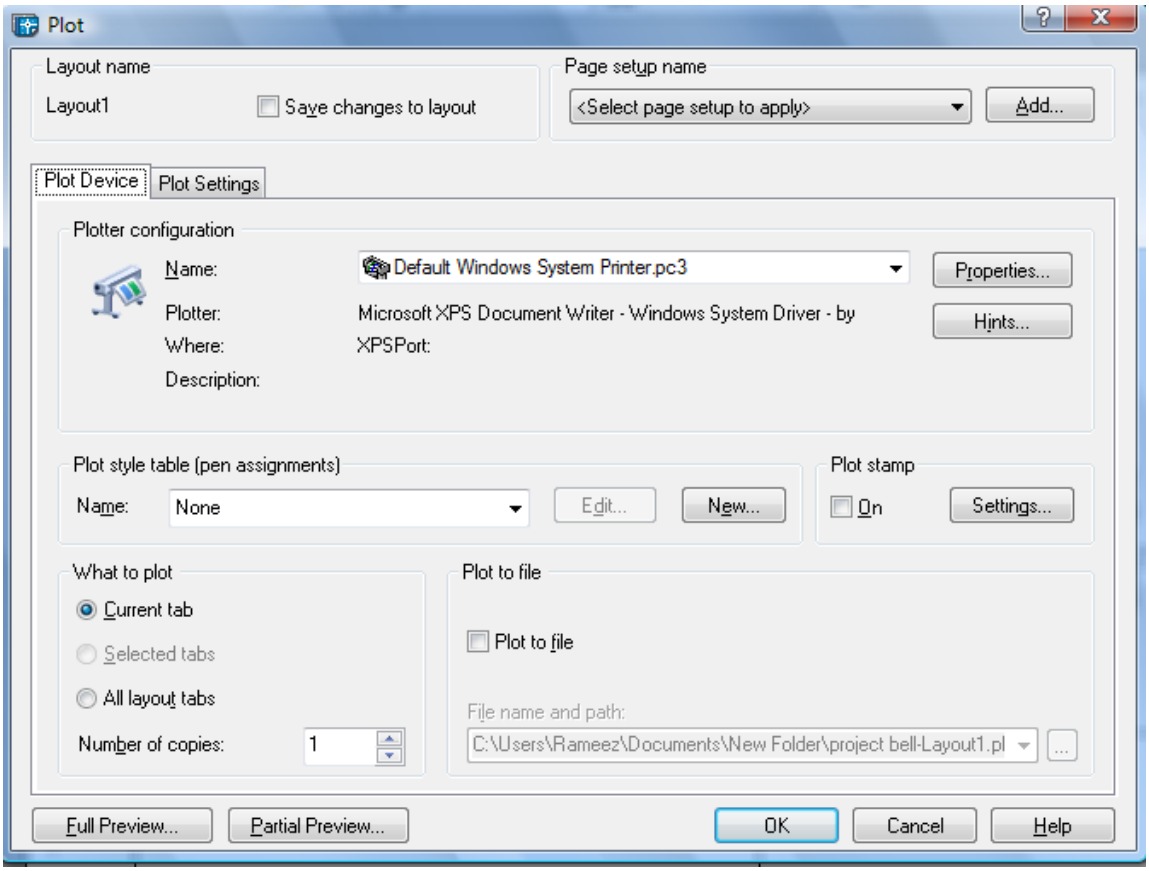
PLOTTERS AND PLOTTING

Plotters and printers should be installed in AutoCAD through the Plotter Mnager.

1. In the ***Tools*** menu, point to ***Wizards*** and select ***Add Plotter.***
2. Work through the wizard, responding to the prompts.
3. At the Plotter Model stage, select from the lists of Manufacturers and Models, or click Have Disk to use the installation disk supplied with the device.
4. Carry on through the wizard.

When you have finished adding to the layout, you can plot it directly, or check the preview first. To do this:

1. Right-click on the layout tab and select ***Plot*** to open the ***Plot*** dialog box.
2. Check the settings, and then click ***Preview*** to see the layout as it will look when plotted.
3. Click ***Save changes to layout*** to save the plot settings with the layout so that you do not have to reset them the next time you plot.
4. Click ***Ok*** to send the layout to the plotter.



APPENDIX

APPENDIX A

BRITISH STANDARDS (BS 308) PART 1

	TYPE OF LINE	LINEWIDTH	EXAMPLE OF APPLICATION
_____	Continuous	0.7mm	Used for visible outlines and edges.
_____	Continuous	0.3mm	Used for dimension lines and leader lines.
_____	Continuous irregular (thin)	0.3mm	Used for limits of partial views or sections when the line is not an axis.
_ _ _ _ _ _ _ _ _ _	Short dashes (thin)	0.3mm	Used for hidden outlines and edges.
___ _ ____ _ ____	Chain	0.7mm 0.3mm	Used for cutting planes
___ _ ____ _ ____	Chain (thick)	0.7mm	Used in identification of surfaces which have tomeet special requirements

APPENDIX B

CHARACTER HEIGHT (BS 308)

APPLICATION	DRAWING SHEET SIZE	MINIMUM CHARACTER HEIGHT(mm)
Drawing Number	A0, A1, A2, A3, A4	7 5
Dimensions and notes	A0 A1, A2, A3, A4	3.5 2.5

APPENDIX C

GENERAL PAPER OUTPUT PLOTTING SPECIFICATIONS (BS 308)

DRAWING SHEET DESIGNATION	PAPER SIZE (mm)
A0	841 * 1189
A1	594 *841
A2	420 * 594
A3	297 * 420
A4	210 * 297